No Index
RETURN TO 207 MARKET ST.
GENERAL
SUPERINTENDENT'S
OFFICE,
ELECTRIC DEPT.
NEWARK, N. J.

The
Practical Engineer

A monthly journal, devoted to the economical generation and utilization of power and to the interests of stationary engineers

VOL. XII PHILADELPHIA, FEBRUARY, 1908. No. 1

THE ACTION OF BOILER DRAFT

BY WALTER B. SNOW.

It is common practice to define the draft as the difference in pressure between the atmosphere and the maximum vacuum produced by a chimney or induced draft fan, or the maximum pressure created by a forced draft fan. But such a basis does not in reality express the effective draft, —the net pressure or vacuum which is directly applied to promoting combustion. Properly speaking, this is the difference between the ash-pit and the combustion chamber pressures; it is this that directly concerns the burning of the fuel.

It is but little realized how much of the draft is expended in merely overcoming resistances, and how little is actually expended in producing air movement. The existing conditions in a given case are displayed in the following statements, which show the pressures in pounds per square foot which were necessary to meet the various requirements of an ordinary stationary boiler furnace:

Required to produce entrance velocity (3.6 feet per second)	0.013
Required to overcome resistance of fire grate	0.91
Required to overcome resistance of combustion chamber and boiler tubes	1.23
Required to overcome resistance in horizontal flue	0.06
Required to produce discharge velocity (11.2 feet per second)	0.085
Total effective draft pressure	2.298
Back pressure due to friction in stack	0.19
Total static pressure produced by chimney	2.488

The total static pressure which is expressed in pounds per square foot is equivalent to 0.28 ounces per square inch, or 0.48 inches of water. From the figures it is evident that by far the greater part of the pressure produced is employed to overcome the resistances which are presented by the fuel, the grates, and the boiler.

The throttling action at the grate is ordinarily sufficient to cause a loss of three-quarters of the entire draft produced by the chimney. As about 75 per cent. of this remaining fourth is necessary to balance the frictional resistances of flues and chimney, there evidently remains only about one-sixteenth of the total head available for the production of velocity.

In a certain case it was reported that about 65 per cent. of the entire head was lost by throttling at the grate, and that only about 4 per cent. of the total head was actually expended in accelerating the gases.

These statements make it manifest that the fan or the chimney is really called upon to do a good deal more than at first appears. Expressed in a practical way, it appears to be the province of one or the other to clear the way for the passage of the air. Just as the power expended to force the snow-plough through drifts is vastly greater than that exerted by the pedestrian who follows in the clear path, so the power which must be exerted to overcome the manifold resistances to the passage of air is greatly in excess of that actually required to move the air.

It may be accepted as a fortunate physical relation that so far as loss by friction is concerned, the volume moved does not vary in direct proportion with the pressure. If so a loss of 50 per cent. in draft would mean an equal reduction in volume. But in point of fact the volume, which is but the product of velocity and area, varies as the square root of the pressure. Hence, 50 per cent. of the pressure difference will move $\sqrt{50} = 71$ per cent. of the volume; so that with only one-sixteenth of the total pressure actually expended to produce air movements, the volume moved is $\sqrt{1\text{-}16} = \frac{1}{4}$ of that which would have been passed through the fuel had there been no resistance, so that the total pressure could be exerted to create velocity.

To only a limited degree can an installation be so arranged as to materially reduce the losses by friction. But nevertheless everything possible should be done to permit of the lowest possible rate of flow through all channels. The terrific rate at which horse-power is lost in friction as the velocity increases, is well shown by the accompanying curve Fig.1. Up to a velocity of about 2000 feet per minute the loss is relatively small, and not noticeably different for considerable change in velocity, but above this its increase is progressively rapid. A velocity of 2000 feet is equivalent to a pressure difference of about ¼ inch of water, while a velocity of 4000 feet represents a pressure of over one inch.

It is obvious that the rate of combustion must be practically proportional to the volume supplied. But it has already been shown that the volume varies as the square root of the draft; so also must be the variation in the rate of combustion. The relation between the total draft and the

rate of combustion does not necessarily preserve this ratio, but the ratio of the net or effective pressure corresponds very closely thereto. An interesting comparison of various pressures and combustion rates is presented in Fig. 2. These relate to careful tests of a 60 in. x 20 ft. horizontal return tubular boiler, burning coal at different rates of combustion. In certain tests the tubes were filled with retarders. The lower line of the curve indicates the calculated draft corresponding to the square root of the rate of combustion. The line just above, which shows the draft in furnace over the fires, is indicative of the real effective draft exerted to produce movement of air through the fuel.

Of course the effective draft required to maintain a given

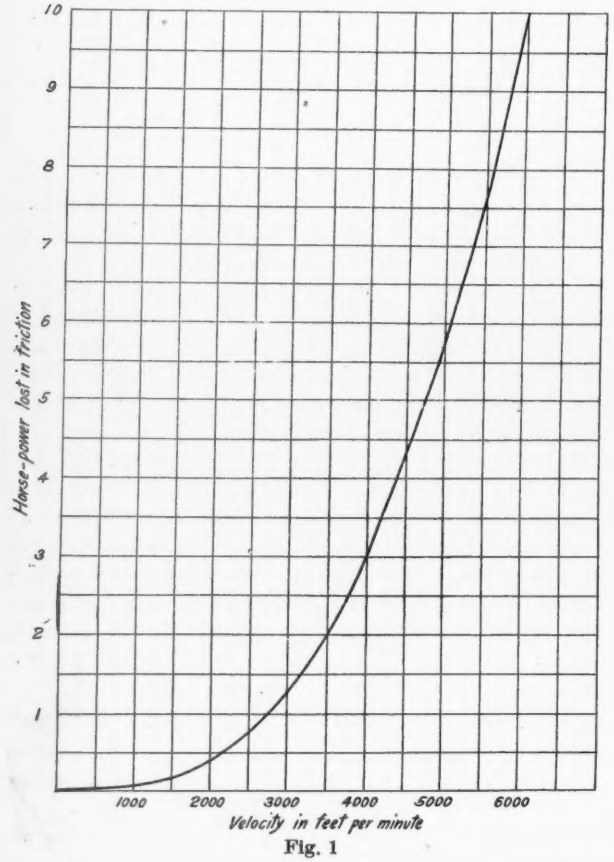


Fig. 1

rate of combustion must depend upon the character of the fuel. While the pressure and corresponding power necessary to overcome friction through the boiler and connections may remain constant, that required to produce velocity through the fuel, and thereby provide the essential volume of air, will increase with the fineness of the fuel.

Careful tests have shown the following approximate results with different grades and sizes of coal, and the same rate of combustion:

Kind of Fuel.	*Total Draft in Inches of Water.*
Slack, very small	0.7 to 1.1
Coal Dust	0.8 to 1.1
Semi-anthracite coal	0.9 to 1.2
Mixture of Breeze and Slack	1.0 to 1.3
Anthracite, round	1.2 to 1.4
Mixture of Breeze and Coal Dust	1.2 to 1.5
Anthracite Slack	1.3 to 1.8

Such a table can, however, only serve as a general expression of relations. The exact draft in each case must be determined by local conditions.

In the preceding is evidenced one of the reasons why mechanical draft is so much more flexible in its application, and much more helpful than a chimney, in getting over extreme conditions. For, carrying the relation between combustion rate and draft above the mean, instead of dropping below, as in the statements already made, it appears for instance that to increase the rate say 25 per cent., it would be necessary to produce $(1.25)^2 = 1.56$ times the pressure. This is the converse of the relation previously expressed. It indicates that the pressure required varies as the square of the rate maintained.

In the casing of a fan, this increase in volume and pressure may be obtained by increasing the speed 25 per cent. In the case of a chimney, however, the draft is exactly proportional to the height, so that an increase of 56 per cent. in height would be necessary to secure an equal increase in draft.

Speeding up a fan is a relatively simple matter, even though for permanent equipment, new power provision

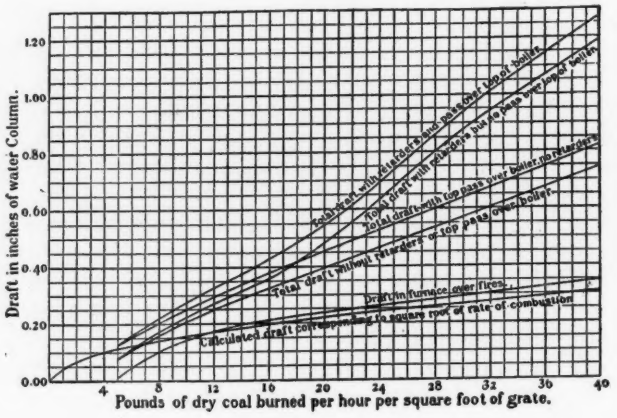

Draft in inches of water Column.
Pounds of dry coal burned per hour per square foot of grate.
Total draft with retarders and passages 100 pf boiler.
Total draft with top pass over boiler, no retarders.
Total draft with retarders or top pass over boiler.
Total draft without retarders or top pass over boiler.
Draft in furnace over fires.
Calculated draft corresponding to square root of rate of combustion.

Fig. 2

be required. But increasing the draft of a chimney is a big undertaking; hence, to provide against such future contingencies, the chimney should originally be built high enough to meet such possible demands. In the meantime capital is held up without useful return.

But from the above statement regarding the speeding up of a fan, it should not be accepted that such practice is proper as a means of meeting heavier requirements. It is usually far better, notwithstanding the initial expense, to substitute a larger fan. The reason is evident in the fact that the power required to drive the fan at 25 per cent. higher speed, and producing 56 per cent. higher pressure, will be $(1.25)^3$ = about 1.95 higher than necessary at normal speed. If the larger volume was delivered by a suitable fan without increase in pressure, the power would have increased only 25 per cent.

As draft is the prime requisite to the combustion of fuel, it is obvious that too much attention cannot be given to the conditions under which it is permitted to secure the desired results. Loss of efficiency once established is constant and cumulative; it should, if possible, be avoided in the original design and equipment.

V621.05 v.12

Machinery and Methods Used for Making Pottery

Power Plant of the Maddock Pottery Co., Trenton, N. J.

By Harry H. Yates.

The average engineer who has changed positions from one kind of factory to another, from time to time, becomes an encyclopedia of information, owing to his experience among the different kinds of machinery which is installed in the various plants. The machinery in a sugar refinery differs materially from that in a leather factory, and the manufacture of china is considerably different from the manufacture of paper, so that if an engineer has a roaming disposition, which many have, his experience in central lighting stations, textile mills, shoe factories, hotels, ice plants, rolling mills and other industries, gives him an insight into the various industries which is both valuable and instructive.

One of these numerous industries which requires machinery more or less peculiar to itself, is the pottery industry, and to one unfamiliar with the manufacture of china, a short description of the process might prove interesting. The raw material when first received is rather rough and requires considerable washing and preparing before it can be used for making ware.

After being mixed in the proper proportions, the clay is thrown into a mixing tank called a "blunger," which contains two vertical revolving shafts fitted with paddles, where with the proper amount of water it is "blunged' until it becomes a thick cream-colored liquid called "slip." It is then run out onto a rapidly vibrating screen or "lawn," which is covered with a very fine screen or bolting cloth which removes all dirt. It then flows through a shallow trench, in which are placed electro-magnets for removing the iron in the clay, to a pit under the floor in which a slowly revolving shaft is fitted with paddles, so as to prevent the ingredients from settling.

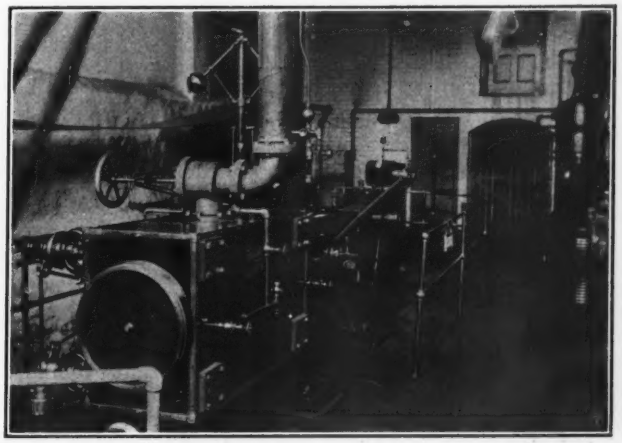
From these pits or agitators, the "slip" is taken by belt driven plunger pumps and forced through presses, which remove most of the water, leaving the clay in slabs about two feet square and about one and one-half inches thick. When removed from the press, it is taken to a cellar, where it is stored, and where during a certain length of time it undergoes an aging process.

When wanted for use, it is put in a machine called a "pug" mill, which is fitted with blades arranged to compress it and remove all air, at the same time forcing it out through an opening in the lower end from which it issues in the form of a roll, eight inches in diameter, when it is cut off and taken to the operator to be made into plates, cups, saucers, or any of the other hundred shapes which are required.

After being formed into proper shape, which takes perhaps five or six different hands, it is dried and then taken by the kilnmen, who place it in fire-clay receptacles called "saggards," and put it in the first or biscuit kiln. After firing several days it is "drawn" or removed from the kiln and taken to the biscuit ware-room, where it is cleaned ready for the "dipper." Some ware has a decoration printed on it before being dipped, in which case it is termed "underglazed."

After dipping, it is taken by other kilnmen and placed in the second or "glossed" kiln, where it is fired again, coming out glossy, finished ware, unless it requires further decorating, when it is taken to the decorating shop. The colors are then applied after which it is again fired once or possibly twice, although not at such a high temperature as before. It then goes to the packing and shipping room.

There are, however, several other steps in the process, such as "dressing," selecting, etc., which it is not necessary to describe, but the whole process from begining to end requires constant care in the manufacture of an article with which we are all familiar, but about the making of which the majority of people know very little.



Engine Room equipped with a 16 x 38 Watts-Campbell Corliss Engine

One of the largest centers of the pottery industry in this country is Trenton, N. J., which is second to none in both the quantity and quality of ware produced. Prominent among the many large potteries in that city, is the plant of the Maddock Pottery Co., who manufacture a high grade hotel china. It is located in the southern part of the city, having a frontage of about 600 feet on Third St., and extending back to the Delaware and Raritan canal to an average depth of 125 feet. The plant has recently grown very rapidly and at the present time it contains 16 kilns, exclusive of the decorating kilns.

As the process of china manfacture requires great care in the preparation of raw materials, considerable machinery for washing, mixing and pressing of the clay is necessary, and being principally of heavy construction, the generation and distribution of power necessary for its operation is of considerable importance.

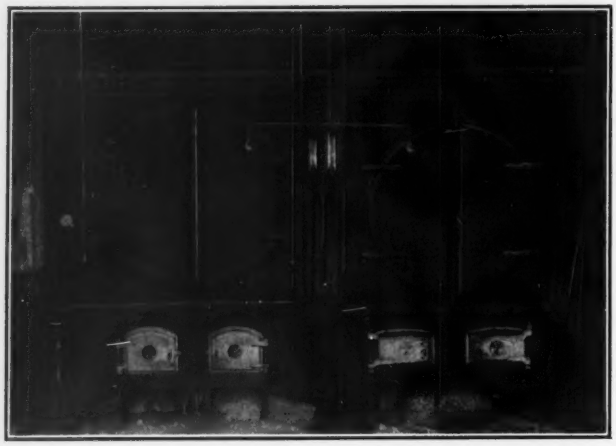
The boiler room occupies a floor space, 16x40 feet, and

contains two horizontal return boilers, one 72"x18' with 100-3½" tubes and 36 square feet of grate surface, and one 66"x16' with 100-3" tubes and 30¼ square feet of grate surface. Both have shaking grates and are hand fired. Natural draft is furnished by a square brick stack about 90 feet high, the flue being carried over the back of the setting, entering the stack about 10 feet above the ground. A damper is placed in each uptake and both are controlled by a damper regulator. The feed pipes enter the top of the boilers near the front head and are carried diagonally about three-fourths the length of the boilers, being suspended above the tubes and are perforated.

A high grade coal is used and with the grates used, firing is easy, little difficulty being experienced in keeping up pressure even in coldest weather, although a large amount of steam is used for heating the shops and dry-rooms. The boiler pressure is 75 pounds and is reduced to 16 pounds for heating purposes. The steam pipes from the boilers are connected to a six-inch header which supplies the engine, and also to a five-inch header, which supplies the heating system through a reducing valve. Each boiler is equipped with two 3" pop valves, each pair of valves discharging into a pipe carried through the boiler room to the outside air.

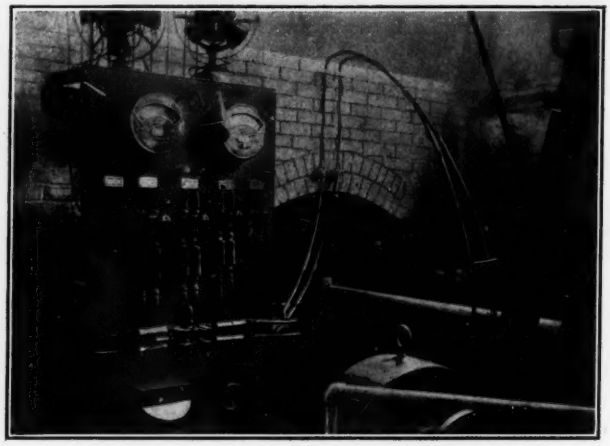
A gravity railway is used for conveying coal from boats on the canal to a bin having a capacity of about 1800 tons, the only power needed in its operation being for the elevation of the coal. The lifting of coal is done by a belt-driven hoisting machine, the buckets being loaded by hand, three shovelers unloading over 100 tons per day. Each bucket holds about 600 pounds and is emptied into a car holding one ton, which runs on an elevated track supported on trestles. When the car reaches a predetermined point it is automatically emptied and returned to the starting point.

The engine room is also 16x40 feet and contains a 16"x38" Watts-Campbell Corliss engine, a 20 K. W. dyna-



Boiler Room of the Maddock Pottery Co., Trenton, N. J.

mo and switchboard, a 6"x4"x6" Worthington feed pump and a closed feed water heater. Space being valuable it was considered preferable to locate the engine so as to lead the main belt back toward the cylinder, and certain conditions of the older part of the plant made it necessary to run the engine "under" in order to bring the pulling side of the belt on the bottom. The supply pipe in the engine is 5-inch and the 6-inch exhaust pipe is led through a trench under the floor to the heater, then vertically to a Burt exhaust head. Near the ceiling is located a weighted back pressure valve and below this valve there is a vertical horizontal pipe which, except in warm weather, carries the exhaust steam to the coils of a 7-foot blower which supplies hot air which heats the lower shops and most of the dry-rooms.



Switchboard, Dynamo and Shaft Alley

The main double 28" leather belt runs from the 8-foot flywheel to an 8-foot receiving pulley, which is mounted on a 7½-foot section of 4 5-16" shafting, which carries on each end a square-jawed, solid clutch, which engages with its mate on each section of the main shaft, making it possible to run either part of the pottery independently of the other in case of necessity. Power for the dynamo is taken from one section of the main shaft by means of a countershaft and runs at 720 revolutions per minute and generates 115 volts.

The switchboard is of slate 36"x60" supported by an angle iron frame anchored to both the floor and engine room wall. It is equipped with volt and ammeter, pilot light, ground-detector, rheostat, five circuit switches and one double throw switch, by means of which the lighting circuits can be connected either to the dynamo or to the alternating current circuit of the Public Service Corporation, as occasion may require. The alternating current watt-meter is also placed on the board below the double-throw swithch. All circuits are protected by enclosed fuses.

The 6"x4"x6" feed pump is located in a pit made necessary in order to get sufficient fall to return the condensation from heating system. The returns are led to a receiver, which is equipped with an automatic float valve control. The large quantity of very hot water that is returned from the heating system is, even with the cold water, necessary to make up for that used by the engine and pumps, sufficient to keep feed water at very near the boiling point so that the heater has very little to do to supply the water at 212 degrees.

The main shaft is carried in heavy, plain boxes supported by brick piers, and being below ground level, it runs

through tunnels where there are no basements. The shaft extends north of the engine room about 300 feet and power for the upper buildings is taken by three pairs of mitre gears. In this part of the works there is located a sand blast equipment consisting of a belt-driven air compressor, exhaust fan, sand tanks, etc., which is used for removing dust and flint from biscuit ware before it is "dipped" or glazed. This equipment, with two operators and assistants, does the work formerly done by about fifteen girls and is an innovation in a pottery. To the south of the engine room, power is supplied to old equipment of machinery by an 18-inch, three-ply leather belt, running vertically from 54"x20" driver to a 36"x20" receiving pulley. The machinery is about the same in both parts of the pottery, and consists of pug mills, lawns, blungers, pumps, glaze pans, jiggers, etc., there being about 60 different machines driven by the engine.

The heating system is divided into two sections, the northern end being supplied by a 4-inch main, and the southern end by a 3-inch main, the condensation from the coils and radiators being discharged into a main return pipe for each end, which in turn discharge into the receiver in the pit in the engine room.

The lighting circuits are led in both directions from a point near the engine room, and all wires have a capacity greatly in excess of their requirements. One circuit, while of small capacity, only about 15 amperes being required, is of considerable importance as it supplies current for energizing the electro-magnets used for extracting any particles of iron from the clay during the washing and pressing operation; one small grain of it preventing a piece of ware from being perfect. A three-wire system of bells and buttons furnish a means of communication between the engine room and principal groups of machinery, current for this being supplied by eight wet cells in series.

The Measurement of Power on Three-Phase Circuits

A Technical Explanation of the Reason Why Wattmeters Read the Correct Power

By E. S. Harrar.

The power delivered to any system by a three-phase generator may be accurately measured by two single-phase wattmeters if properly connected. The usual method, however, is to use one polyphase wattmeter, which is virtually two single-phase meters with moving elements mounted on the same shaft, this shaft driving the recording train, or actuating the pointer, as the case may be. In this way, since the turning effort is all exerted on one shaft, the meter will indicate the sum (or difference) of the turning efforts of the two moving elements. If two single-phase meters were connected like the two parts of the polyphase meter, the sum of their readings would also be equal to the total power, except in cases where the power factor of the load was less than 50 per cent. In such cases one meter would read backwards, and it would be necessary to subtract the backward reading of one meter from the forward reading of the other, in order to get true power. By using the polyphase meter this procedure is obviated since the pointer indicates directly the difference in turning effort when the power factor is less than 50 per cent. Two single-phase wattmeters, when properly connected through special transformers, can, however, be made to indicate true power on a three-phase system for all conditions of loading and power factor.

Fig. 1 shows the usual method of connecting the two parts of a polyphase wattmeter to measure power delivered by a three-phase generator. A, B and C represent the windings of a three-phase armature, delta-connected. The arrows indicate the direction of the circulating current when positive (arbitrarily assumed). W_1 and W_2 are the two parts of the polyphase wattmeter. For a balanced, non-inductive load the power delivered is $P = EC$, where $P =$ total power, $E =$ voltage across each winding, and it now remains to be proved that the sum of the readings of W_1 and W_2 is equal to the total three-phase power, or EC.

A vector representation of the currents in the windings A, B and C is shown in Fig. 2, and since the current in each winding is in phase with the voltage of that winding, the line OA, OB and OC represent the direction of both voltage and current in the different windings.

In Fig. 1 it can be seen that a current in line 1 in the direction of the arrow will have the value $+ B - C$, or in the reverse direction the value $- B + C$, or $- (B - C)$. Hence, no matter what its direction is, its value is $B - C$, and this is seen in Fig. 2 to be equal to $2C$ cosine 30° and is 30° behind OB in phase. Hence, the power measured by W_1, which gets its current from line 1 and its voltage from phase B, is equal to

$$P_1 = 2\,EC \cos^2 30° = 3\,EC \div 2$$

or $P_1 = \frac{1}{2} P$

In the same manner it can be shown that the power measured by W_2 is also equal to $3\,EC \div 2$, and the sum of the two readings is equal to the total three-phase power delivered.

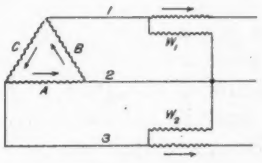


Fig. 1

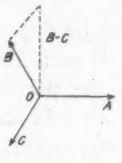


Fig. 2

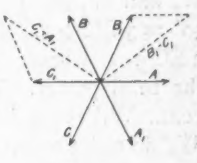


Fig. 3

It is not necessary to connect the wattmeter on three-phase circuits to calibrate it, as this can be done more conveniently on single-phase circuits, as follows: Select a meter having full scale marking equal to total three-phase power. Connect one part of meter on a single-phase circuit and adjust pointer so that the one part will cause pointer to indicate one-half scale deflection for true power equal to one-half total three-phase power. Repeat for other

part of meter as a check, and meter is then calibrated for use on three-phase circuits. For example, a polyphase wattmeter, having full scale marked 25 K. W., and for use on 100-volt circuits, should be calibrated as follows: One-half total three-phase power equals 12½ K. W., or 12,500 watts. The corresponding current at 100 volts, single-phase, is 125 amperes, hence set pointer to indicate one-half scale, with 125 amperes in one part only of wattmeter. Repeat with other part of meter, and same is then calibrated for use on three-phase circuits. On three-phase circuit the current in each line corresponding to 25 K. W. at 100 volts is 144.4 amperes, and differs 30° from voltage, hence the power indicated by each half of meter is $100 \times 144.4 \times \cos 30°$, or 12,500 watts, as before.

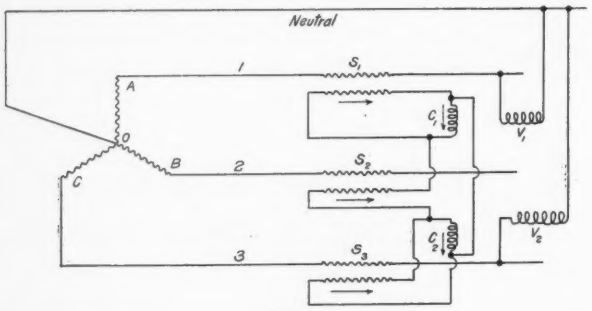


Fig. 4

In the fore part of this article mention was made of loads of 50 per cent. power factor and less. Fig. 3 shows the voltage and current relations for a three-phase system, with power factor of load equal to 50 per cent. In this case the current in each winding lags 60° behind the voltage of that winding, and in our vector diagram takes the positions represented by the lines A_1, B_1 and C_1, Fig. 3, or 60° behind the lines A, B and C, which represent the phase of the respective voltages. Here $B_1 - C_1$, which is the current W_1, would take, is again equal to $2\,C \cos 30°$, but it now lags 90° behind voltage of phase B, which is the phase from which W_1 gets its voltage; hence, power measured by W_1 is $P_1 = 2\,EC \cos 30° \cos 90° =$ zero. In like manner $C_1 - A_1 = 2\,C \cos 30°$, and is actually 150° ahead of phase A, which is equivalent to 30° behind, as the meter terminals are so connected that W_1 will read forward when $C_1 - A_1$ lags between 90° and 270° behind voltage A, in order to make W_1 and W_2 additive. Therefore W_2 reads $P_2'' = 2\,EC \cos^2 30° = 3\,EC \div 2$. The total power is $3\,EC \cos 60°$, or $P = 3\,EC \div 2$, whence it is seen W_1' reads zero and W_2'' reads the total power. If the power factor is less than 50 per cent., W_1' reads backwards and must be subtracted from W_2'' in order to get true power. Thus, at 40 per cent. power factor $P = 3\,EC \times .4 = 1.2\,EC$, and

$P_1 = 2\,EC \cos 30° \cos (30° + 66° 25') = \sqrt{3} \times .112 = .194\,EC$

$P_2 = 2\,EC \cos 30° \cos (30° - 66° 25') = \sqrt{3} \times .805 = 1.396\,EC$, and

$P = P_2 - P_1 = 1.2\,EC$, which the polyphase meter will indicate correctly, since both moving elements are on one shaft.

A three-phase system frequently used is the four-wire star connection, shown in Fig. 4. A, B and C represent the windings of a three-phase star-connected armature, or of three single-phase transformers, star-connected, with common terminal O. From the free ends of the windings A, B and C, the line wires 1, 2 and 3 are taken, and from the common terminal O the fourth, or so-called neutral, is taken.

Let E = voltage across each winding, which will also equal voltage between neutral and any line wire.

Let C = current in each of the windings.

Then total power = P = 3 EC, and it remains to be proved that the sum of the readings of the two parts of a polyphase wattmeter, when connected as shown in Fig. 4, is equal to 3 EC.

In this figure S_1, S_2 and S_3 are three series transformers which are necessary for the proper connecting of meter coils. C_1 and C_2 are the two current coils, and V_1 and V_2 are the two voltage coils. The arrows indicate positive direction of current (arbitrarily assumed).

From Fig. 4 it is readily seen that the current in each line wire is the same as the current in the corresponding winding, and has, consequently, the same value and phase relations. Also, the voltage between neutral and any line wire has the same value and phase relation as the voltage of corresponding winding. Hence, for non-inductive loads the voltage between neutral and any line wire is in phase with the current in that line wire, and their product is equal to the output of the corresponding winding, so that in the above expression for power C is also equal to the line current.

It is also seen from Fig. 4 that current coil C_1 is connected directly to the terminals of transformer S_1 and that C_2 is connected directly to terminals of S_3, and that current from S_2 flows through both C_1 and C_2 in series in such a manner that the resultant current in C_1 is the vector difference of S_1 and S_2, and in C_2 it is the vector difference of S_3 and S_2. In Fig. 2 it is shown that this resultant is $2\,C \cos 30°$. The current in coil C_1 is therefore equal to A — B, Fig. 2, and is 30° behind A in phase, hence as V_1 gets its voltage from winding A, the power measured by one-half of meter is $2\,C \cos 30° \times E \times \cos 30°$, or $2\,C \cos 230°$, whence finally power measured by one-half of meter is $P_1 = 2 \times \frac{3}{4} \times EC = 3\,EL \div 2$, similarly power measured by other half is $P_2 = 3\,EC \div 2$, and the sum of the two reading is 3 EC, or P.

This result may also be deducted as follows: Disregarding for the present the connections of transformer S_2, it is seen that one part of the meter measures the power delivered by winding A and the other part measures the power delivered by winding C. Now, referring to connections of S_2, it is seen that the current output of winding B is measured once by coil C_1 and voltage coil of corresponding part of meter gets its voltage from winding A. This current and voltage differ by 120°, hence the power measured by C_1 and V_1, due to current in winding B, is $EC \cos 120°$, or ½ EC; that is, one-half output of winding B. Similarly, the other part of the meter measures current in winding B and voltage of C, and the sum of the two readings is EC, or the output of winding B.

Cost of Constructing Steam-Driven Electric Power Plants

By Frank Koester.

The cost of steam power plants is determined by the location and by the character of the building and equipment. The amount of capital available also plays an important part in determining the equipment. Mistakes have been frequent in selecting the type and size of various portions of the equipment, and in such cases it has been evident that the use of other machinery (perhaps lower-priced) would bring better results. Herein the broadness of experience in the designer counts largely. It is not the province of the designer to design special machines but to properly select machinery already on the market. Such a broad experience is necessary to secure that judgment in selection which it is evident many designers lack. A thorough business knowledge is essential for securing the most suitable machinery at a minimum of expenditure. The proper and economical assembling of the various parts needs to form an important part in the designer's experience.

The figures given herein for the cost of power plants are derived from plants whose designers may be said to fairly fulfill the above requirements. These costs represent an average arrived at by the comparison of costs of various plants with which the writer has been connected, directly or indirectly in one way or another, during a considerable experience in the design and erection of such works. The costs represent recent practice and are quoted per KW. capacity.

Building.—Judgment in the architectural treatment and the selection of stock sizes of doors and windows will very materially keep down the first cost of the building. Some of the more prominent plants of the country vary widely in the cost of their superstructure, and it cannot always be said that the more expensive building is the most pleasing to the eye. In the design of the superstructure, the character of the building as a power plant must be kept in mind. Comparatively the cost of the superstructure for a plant of small capacity will be greater per KW. capacity than the cost of the larger plant. The superstructure for plants up to 5,000 KW. capacity costs from $15 to $25 per KW. The former figure may be secured by a compact arrangement with walls of common brick, wooden doors and window frames, steel roof trusses supported by the walls, and a roof of the cheapest fireproof construction, such as corrugated iron, tin, etc.

The other type of building, costing about $20 to $25 per KW., may be constructed of higher grade masonry with fireproof windows and doors, roof trusses carried by steel columns which at the same time carry the crane runway, and the roof itself consisting of reinforced concrete covered by tar and gravel.

The cost of the superstructure for large size plants usually runs from $10 to $20 per KW. These are constructed of a self-supporting steel skeleton and self-supporting walls. superstructure at $20 per KW. may embrace multiple boiler while those at $10 per KW. cover single boiler floor plants only. In both cases coal bunkers are provided. In the lower cost building steel bunkers of five to eight tons capacity per running foot are installed. In the multiple boiler floor building the bunkers are made up of structural steel, the beams being filled in with masonry arches, the side walls also being of masonry filling.

Chimney.—The cost of the chimney depends largely on the location of the plant, the proximity to the source of the particular kind of materials constituting an important factor, as the cost of transportation of materials is a large item, steel chimneys being cheaper in such localities where transportation costs favor such construction.

Furthermore, the competition among builders of chimneys, and especially since the introduction of the reinforced concrete chimney, is so strong that a radial brick chimney may sometimes be had as cheap as a steel chimney or reinforced concrete chimney.

A radial brick chimney for large sized power plants may be built from $1.75 to $2.25 per KW. Reinforced concrete chimneys and plate steel chimneys may cost from $1.50 to $2 per KW.

Coal and Ash Handling Systems.—The cost of coal and ash handling systems is difficult to determine, depending so largely as it does upon the manner in which the coal is received from the shipper, the way the ashes are disposed of and the distance through which the coal as well as the ashes must be handled. Experience shows that the figures for equipment for handling coal and ashes range from $1.50 to $3 per KW.

Boilers.—The cost of water tube boilers ranges from $8 to $10 per KW., depending upon the square feet of heating surface in the boiler. These figures do not include mechanical stokers, for which from $2 to $3 may be assumed. Breeching, of course, is also a separate item and varies considerably as to cost per KW. The boiler setting is included in the cost of boiler given above.

Blowers.—In many of the modern power plants, especially plants for railway purposes, forced or induced draft is adopted. The blowers are usually steam-driven. The cost of such equipment is about $1 per KW.

Economizers.—Where economizers are installed of sufficient capacity to heat the water to 200° or 220° F. such apparatus costs about $2 per KW., provided that there are not too many additional smoke flues necessary for by-passing, etc.

Boiler Feed Pumps.—The cost of such pumps alone is some 50 cts. per KW. When storage tanks are necessary, the cost of the combined outfit amounts to 75 cts. or $1, depending on the number and size of the tanks.

Piping.—In some stations piping has been installed for $2 per KW., while in others as high as $6 per KW. has been paid. This includes all high and low-pressure piping (steam and water).

For plants varying from 10,000 to 20,000-KW. capacity, the piping system not being elaborate but sufficient for con-

*Engineering News.

tinuous operation, $2.50 to $2.75 has covered the cost. This includes a high grade of covering for steam piping valued at about 20 cts. per KW.

Prime Movers.—While the price of the prime movers varies with the size of the units, it also varies with the type of machine. The price of turbines is often governed by the price of reciprocating engines, although the former can be produced cheaper than the latter. Although the condensers for a turbine cost more than for a reciprocating engine the complete turbine generating unit ordinarily should

TABLE I.—COST OF STEAM TURBINE PLANTS.

Excavations and foundations	$ 2.00	$ 2.50
Building	10.00	15.00
Tunnels (condenser water conduit)	1.75	4.00
Flues and stacks	2.50	3.50
Boilers and stokers	8.50	12.00
Superheaters	2.00	2.50
Economizers	2.00	2.25
Coal and ash handling systems	1.50	3.00
Blowers and ducts	1.00	1.50
Pumps and tanks	1.00	1.25
Piping systems	2.25	4.50
Turbo-generators	22.00	25.00
Condensers (surface)	5.00	8.00
Exciters	.75	1.00
Crane	.25	.50
Switchboards	2.00	3.50
Plumbing, painting, labor, etc.	1.00	2.00
	$65.00	$103.00

cost considerably less. A 5,000-KW. turbo-generator should cost from $20 to $22 per KW. Reciprocating engines of this capacity are sold roughly at the same price, and about $10 per KW., needs to be added for the generator. The total cost for smaller units, 600 to 3,000 KW. capacity, is from $20 to $25 per KW., whether they consist of turbine or reciprocating-engine aparatus.

Condensers.—The cost of condensers depends very much upon the vacuum desired and on the type of condenser. The cost of jet condenser equipment runs from $3 to $5 per KW., depending upon the type of pump used. The cost of surface condenser apparatus will vary from $5 to $8, depending partly upon the vacuum to be carried and whether the casing necessary forms part of the condenser equipment or is provided as part of the turbine shell, as is the case in the Curtis base-condenser turbine, in which case the above figures may fall as low as $3 per KW.

Exciters.—A steam-driven exciter unit costs from 35 cts. to 40 cts. per KW. If a condenser should be installed in connection with it the cost may run as high as 70 cts. per KW., assuming that the exciter capacity is, approximately, 1% of the total capactiy of the plant.

Switchboards.—In considering the cost of a switchboard equipment only such switchboard is herein considered as is necessary for the operation of the plant and the outgoing feeders, not including substation boards. The will vary with the voltage adopted for the system. For a high tension voltage the cost will run from $2 to $3.50. while for a low tension voltage (2,300 volts and lower) the switchboard equipment may be obtained for $1 to $2 per KW., depending largely upon the system of wiring adopted.

Miscellaneous.—There are many other items which must be figured in the complete cost of the plants, such as traveling cranes, which will amount to 25 or 50 cts per KW. Smaller items like house pumps, water meters, blow-off tanks, painting, supervision, etc., may total from $1 to $2 per KW.

Tabulations.—A summary of the prceding figures is shown in Tables I, and II. To these summarized costs there needs still to be added the engineering fee which in many cases is figured as a percentage on the total cost.

It should be noted that the first column of figures in each table represents costs which are exceptionally low and may be attained under favorable conditions with engineering skill. The second column of figures in each table represents fair average figures as ascertained from the costs of a number of plants recently erected. However, plants have been installed which cost as much as $125 per KW., and in an exceptional case the cost approximated $150 per KW.

All these figures represent costs of plants of large capacity. Small plants of about 3,000 KW. capacity have been erected in the West at from $120 to $130 per KW., which costs may be reduced if a simple combination of machines is provided.

Referring to these tables, it will be observed that the turbine plant varies from $65 to $103 per KW. The main items constituting this difference are: building, turbo-generators and condensers. The difference in cost of these is due to the type of turbine, the size and make of condensers and their auxiliaries, as well as the manner of assembling, all of which may reduce the size of the building required.

TABLE II.—COST OF RECIPROCATING ENGINE PLANTS.

Excavations and foundations	$ 3.00	$ 5.00
Building	10.00	20.00
Tunnels (condenser water conduit)	1.50	2.75
Flues and stacks	2.50	3.50
Boilers and stokers	8.50	12.00
Superheaters	1.75	2.25
Economizers	2.00	2.25
Coal and ash handling systems	1.50	3.00
Blowers and ducts	1.00	1.50
Pumps and tanks	1.00	1.25
Piping systems	2.50	5.00
Engines	18.00	22.00
Condensers, jet	3.00	5.00
Exciters	.75	1.00
Generators	10.00	12.00
Crane	.25	.50
Switchboards	1.00	2.00
Plumbing, painting, labor, etc.	1.00	2.00
	$70.25	$104.50

The difference in cost of boilers is due to the make or type and the rating of the boiler horse-power adopted by the plant designer per KW. capacity. This ratio varies greatly. Plants have been installed with the same type of boiler and the same type of prime mover in which the ratio varies, one value being 0.60 boiler horse-power per KW. generator capacity, while in other cases it is 0.75 and 0.80. This difference depends upon the experience and judgment on the part of the designer as well as the estimated ability of the future available operating force to produce steam effectively.

The difference observed in the cost of the other items may be explained by the difference in the grade of material used and the ability of one purchaser over another to secure the lowest market price.

A 6-in. x 8-in. VERTICAL GAS ENGINE

Specially Designed for the Practical Engineer

By A. Edward Rhodes.

Part II.

The crank case or main frame is shown in Figs. 11, 12 and 13 and is the largest casting used in this engine. It is box-shaped, and therefore the pattern and machine work is quite simple. The design does not follow the usual shape for this part of the engine, but it was thought better to sacrifice beauty and save pattern making. The pattern should be made in two halves, dowelled with pins to hold them in position when they are together in the sand. The core is well supported at the top, bottom, front, back and sides. The top of the frame is finished on the planer, and has four ¾" studs or bolts as preferred. The ½" holes for the valve rod should be drilled at the same setting as when drilling for the ¾" studs, the ½" holes being reamed smooth after drilling. The bosses for the valve rod holes must be made loose on the pattern, or the space between them must be filled with metal, so the pattern can be lifted out of the sand when parted on the horizontal center line shown in Fig. 11.

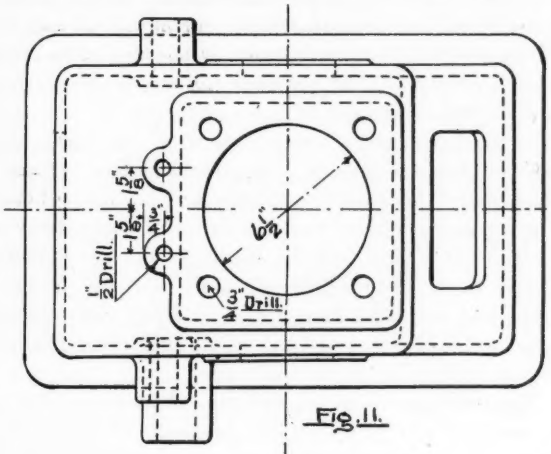


Fig. 11.

In machining this casting, great care must be taken to have the holes for the crank shaft bearings exactly in line parallel with the top face of the top casting, and the bosses around them should be faced at the same setting, although some may prefer planing these bosses at the same time that the top and bottom of the casting is machined. A piece of cast iron ¾" or 1" thick, 13" wide and 20" long, finished on one side, should be provided as a base-place and bolted on the bottom of the crank case, using six ½" tap bolts.

The several hubs for the shafts should be bored in line with the holes for the crank shaft bearings, being sure that the distance between the centers corresponds to the pitch diameters of the gears. Hand holes, 6"x9", are provided both front and back. These holes will be covered with plates of cast iron ½" thick, 9" wide and 13" long, fastened by six ½" tap bolts. As no finish is provided for these

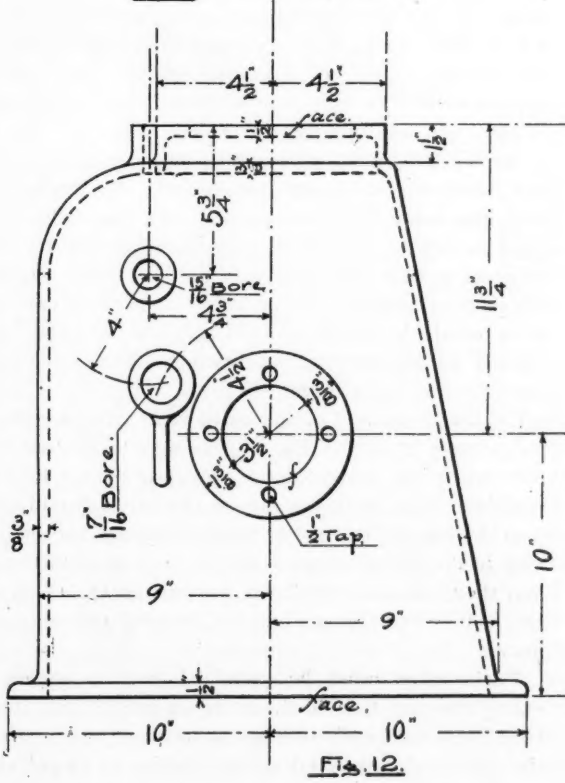


Fig. 12.

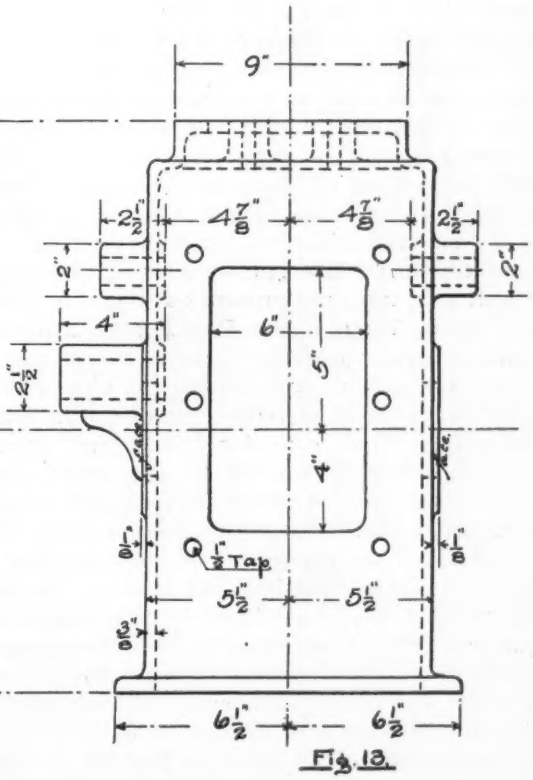


Fig. 13.

plates, it will be best to use a rubber gasket to keep the water and oil in the crank case from splashing out when the engine is in operation.

The crank shaft bearings, shown in Figs. 14, 15, and 16, are of cast iron, finished all over and fitted at the 3½" diameter to the holes in the crank case. If the machine work is properly done, this insures perfect alignment of the crank shaft. It will be noticed that no adjustment is provided for taking up wear. It it not necessary to do so, because the crank pin is under more or less compression strain at practically all times. If it is desired to take up wear at some future time, these bearings may be rebored, then bushed and babbitted. The bearings are bolted to the crank case with ½" bolts. It will be necessary to put the crank into the crank case before the bearings can be bolted in place. An oil hole must be drilled in each bearing.

The crank shaft, shown in Figs. 17 and 18, may be a forging or it may be made of cast steel. Its throw is 4" and is finished all over. It is fitted with two cast iron weights, shown in Fig. 19, which are machined on a planer where they fit on the crank shaft arms. Each weight is held in place by a ½" bolt which should be riveted so the nut cannot work loose. Considerable care and experience is required in machining a crank shaft to get and keep it true to shape and alignment. For the balance wheels and belt pulley, ⅝" keyways are provided, and for the cam gear, a ½" keyway. The lengths given for the crank shaft may be changed to suit the fancy of the designer, or as the conditions, under which the engine must work, may require.

The wheel gearing consists of four cut gears of 1" face, having 16 and 32 teeth, all assembled and geared together to drive the cam shaft at a ratio of one turn to two turns of the crank shaft. The gear A is 3" pitch diameter, has 16 teeth and is bored 1¾" to fit the crank shaft, to which it is keyed. Gear B is driven by gear A and is 6" pitch diameter, 32 teeth, and is bored 1 7/16" and keyed to fit the intermediate shaft. This gear, in addition to driving the cam shaft gear, takes the outward end thrust of the intermediate shaft. The cam gear, D, is 4" pitch diameter, has 16 teeth, is bored 15/16", and is keyed to the cam shaft. This gear acts as a collar to prevent end play of the cam shaft in one direction, and a set collar prevents end play in the opposite direction as shown in Fig. 17. Some persons, before boring the hubs for the gear shafts, prefer to lay the gears in mesh on a sheet of paper, so as to measure and test for the exact distances between centers. This is not necessary if the builder is sure that the pitch diameter of the gears are exactly as the drawing calls for. As a rule, cut gears can be purchased from the standard stock of gear makers, for considerable less than the average shop can make them. Any diameter of gears may be used, so long as the ratio one to two is maintained, and the centers of the shaft hubs are made to correspond.

The intermediate shaft, shown in Feg. 17, is a piece of cold-rolled shafting 1 7/16" diameter, 7" long, one end being keyed to gears B and C, which will be inside the crank case and press against the inside of the hub. On the outer end of this shaft is a set collar, which will press against the outer end of the hub, thus holding the shaft in position.

The cam shaft, shown in Fig. 17, is a piece of cold-rolled shafting 15/16" diameter, 20" long, on which is keyed the gear D and the inlet and exhaust cams. Great care should be exercised in setting these cams in position. The inlet, shown in Fig. 20, should be lifted 7/16" and held open during 174 degrees of the revolution. The valve should open at 9 degrees past the upper dead center to allow the incoming gases to completely fill the compression space.

The axhaust cam, Fig. 23, should lift the valve 9/16" and hold it open during 218 degrees of the revolution. Set the cam to open the exhaust valve 35 degrees before the lower dead center is reached; then the valve will close at 3 degrees past the upper dead center, which gives 6 degrees of revolution between the closing of the exhaust and the opening of the inlet valves. When the valvs are closed, there should be 1/16" between the nut on the valve stem and the upper end of the valve rod.

In assembling the several parts of the shaft, the keyway and key for cam, Fig. 22, should be first cut and fitted. Then place the shaft in position and set the exhaust cam, Fig. 23, and mark the position of the keyway for it and for the gear D. Next, remove the shaft, cut the keyways and fit the keys, after which the shaft is ready to be put in place and the keys driven home. *Don't cut keyways until both cams have been set and tried*; that is until both cams lift the valves at the proper time.

The inlet cam, Fig. 22, and the exhaust cam, Fig. 23, are of machine steel, finished all over and the faces case-hardened. It may be desirable to fasten these cams by drilling a 5/16" hole through the cam and shaft, and fitting a round pin, instead of cutting a key as shown. The valves, Fig. 20, are shown as they would be made if the proper grade of steel can be obtained. The best steeel for this purpose is known as special valve steel, and contains about 5 per cent. carbon and 30 per cent. nickel. The nickel tends to keep the valve from overheating, and the carbon makes it hard enough to wear well. A good substitute for this special steel is cast iron, which is used in many engines with satisfactory results. If the valve is made of cast iron, the stem would be made of steel screwed into the valve and riveted to prevent its unscrewing. The valve and stem must be finished all over.

On the lower end of the valve stem is a specially-shaped nut, shown in section Fig. 20, having a projection ⅞" diameter fitting the inside of the valve spring for holding it in position. The 45-degree face of the valve should be ground into the seat by the use of powdered glass and oil. A good way to do this is to cut a slot in the top of the valve stem and then use a screw-driver bit and brace. There will be two valves like Fig. 20, one for the inlet and one for the exhaust.

Each valve must be provided with a spring, having enough tension to hold the valve on its seat and at the same time have too much tension as to cause undue wearing of the parts. A tempered spring of No. 20 round steel wire coiled on a ⅞" diameter rod and ¼" pitch will be about right.

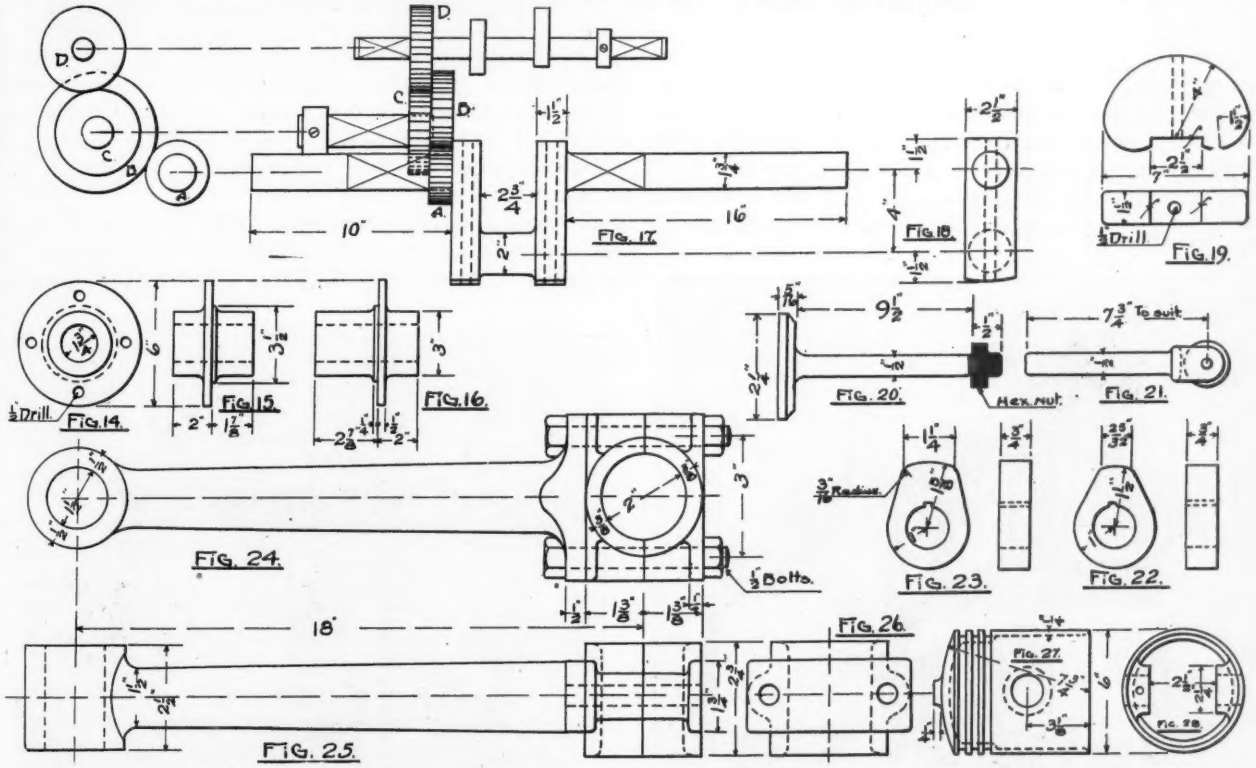
The valves receive their motion from the cams through the valve rods shown in Fig. 21. These rods are ½" diameter, and have a fork on the lower end for hold-

ing the hardened-steel friction roller. This roller may be 1" diameter by ½" thick, and has a ⅜" diameter hole which turns about a pin riveted in the fork. If the metal in the fork is ¼" thick on each side of the roller, and the roller has just enough side play, the ⅜" pin will be 1 1/16" long, which will allow the pin to project 1/32" on each side of the fork for riveting.

The length of the valve rods may best be determined by trial; that is, they must be of such a length that when the cam is in its lowest position, the valve will be closed, and there will be exactly 1/16" between the valve rod and the nut on the valve stem. When this is attained, the valves will lift the desired amount. Some builders of gas engines make the exhaust valve larger in diameter than the inlet valve, but in this engine they have been made the same, with the exhaust valve having the greater lift, so that they can be interchanged, and for ease of construction.

The piston, Figs. 27 and 28, is of cast iron, of the usual cylindrical or trunk construction. It is 8" long and 6" diameter full, and after being carefully turned, is ground to a proper diameter in oil, by flushing with oil and forcing the piston in and out of the cylinder until a smooth, polished surface is obtained. This rubbing with oil may not be absolutely necessary, but it pays to do so.

The piston is provided with three snap or spring rings ⅜" wide, bored eccentric, ¼" thick at thickest part and ⅛" thick at the thinnest part. These rings are made of cast iron, and should be turned ⅛" larger than the bore of the cylinder; that is, the outside diameter, before the ring is split, will be 6⅛" and the inside diameter will be 5¾", with the center shifted 1/16" out of true, after the outside is turned and before the inside is bored. In practically all machine shops, it is customary to cast a cylindrical tube long enough to make a number of piston rings for one engine of a given size. In this case a tube 6⅜" outside diameter, 5½" inside diameter and 2½" long will give enough stock to turn the three rings, cut them off, and leave enough for chucking in the lathe.



The connecting rod, shown in Fig. 24, consists of five pieces:—the wrought-iron rod, two pieces of manganese bronze for the crank bearing and two ½" bolts for securing the bronze bearings to the foot of the rod. The piston end of the rod should be bored 1½" and faced 2½" to fit the piston. The crank end has a foot 1¾" by 4", faced parallel with the hole in the piston end. The bronze bearing is made in two pieces, exactly the same shape and size, bolted to the foot of the rod and bored 2" to fit the crank. Care should be exercised in drilling the bolt holes and in fitting the bolts, also in drilling the 2" hole that it may be in perfect alignment with the hole in the piston end. This will prevent trouble of the kind no engineer is seeking. Many engineers prefer to insert liners in the crank end before boring, and, as wear occurs, removing them one at a time. This may easily be done.

The piston is bored 3" from the lower end to receive the 1½" diameter cross-head pin. This pin is of wrought iron or steel, finished all over, and is 5¾" long. There should be a ½" hole bored through it lengthwise and communicating with an oil hole in the center of its length, both for oiling the piston end of the connecting rod. The piston pin is held in place by a ½" set screw, tapped in one of the hubs, on the inside of the piston. It would perhaps be considered a better construction to make the piston pin of three diameters, bore one side of the piston smaller and the other side larger than the hole in the piston end of the connecting rod. The holes for the piston pin must be square with

the diameter, for the same reason that the crank shaft should be in perfect alignment.

As regards the balance wheel, it would be best to select them from the stock patterns of some foundry, rather than attempt to make a pattern. The cost will not be as great, and the wheels are more likely to be more perfectly shaped, round and true. A wheel pattern about 30" diameter, 5" face and 3" rim thickness, will have about the right weight to run ordinary machinery. For special work, the wheels must necessarily vary from this weight; that is, if the engine is to run an electric light dynamo, the wheels should be 1/3 heavier. This extra weight may be obtained by increasing the thickness of the rim or by slightly increasing the diameter of the wheel. The belt pulley may be of any diameter to suit the conditions, and may be purchased cheaper than it can be made. This is also true of the carburetor, which is used for mixing the air with the gases before they enter the cylinder. To this carburetor, should be attached a governor, which will also control the lift of the inlet valve.

The engine will also require a spark plug, a spark coil or magnets, as preferred, a switch and some batteries. A muffler may be used if the neighbors are to be considered, or for other reasons.

(To be continued).

STEAM TURBINE CONDENSING EQUIPMENT

Methods in General Use for Obtaining Good Vacuum

One of the necessities in the economical operation of steam turbines is a satisfactory condensing equipment; as the steam turbine, to compete successfully with modern up-to-date reciprocating engines, must be supplied with superheated steam and work with a high vacuum.

The accompanying illustrations, Figs. 1 and 2, show a turbine condensing equipment, the former operating in connection with a vertical high-power Curtis turbo-alternator, and the latter with a horizontal Parsons steam turbine.

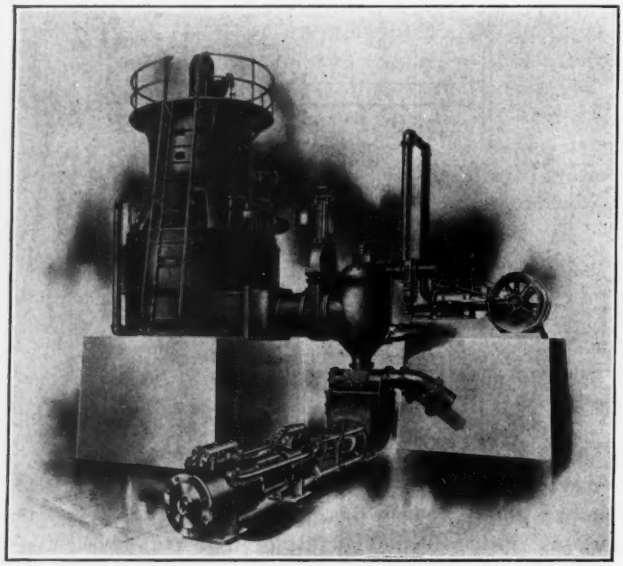


Fig. 1

The small area required for foundations with the steam turbine usually give plenty of room for the condenser pump in the basement, while the dry-air pump is usually mounted on the main floor with the turbines and alternators, as shown in the illustrations. The type here indicated is a single-horizontal rotative dry-air pump, the several parts being secured together so as to maintain proper alignment and make the machine entirely self-contained. An efficient system of water jacketing is generally provided in this type of air pump, and the clearance is reduced to a minimum, the arrangement of the inlet valve being such as to open communication between the two ends of the cylinder at the end of each stroke in order to equalize the pressures and prevent re-expansion and increasing the volume at efficiency.

The accompanying illustration, Fig. 3, shows a single horizontal compound vacuum pump, with jet condenser, as is used in Figs. 1 and 2, with the vertical and horizontal

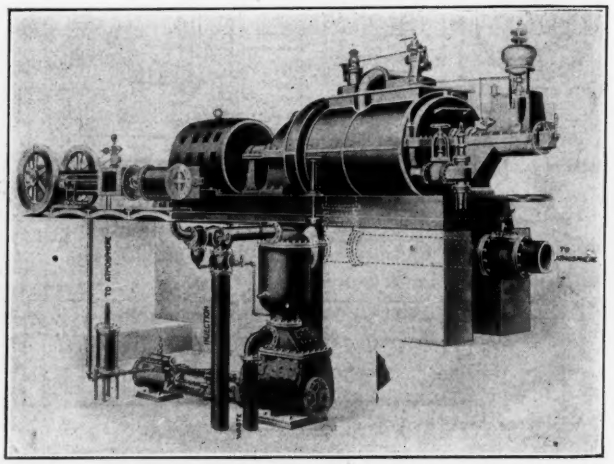


Fig 2

turbine, while Fig. 4 shows the construction of a single, vertical, compound, direct-acting vacuum pump and jet condenser. The condenser shown in Fig. 3 is provided with an arrangement for separating the air from the water and taking the air out through a super-cooler by means of the rotative dry-air pump, which arrangement is said to not only meet the requirements of low cost, but also has high economy, giving a high efficiency.

The single, vertical, compound, direct-acting vacuum pump, with jet condenser, shown in Fig. 4, is desirable where the space required by a horizontal vacuum pump is not available. In this equipment the steam cylinders are placed vertically above the vacuum cylinders and rigidly

connected thereto, the latter being of a new double-acting type, with large valve area and direct passages, and having a constant water sealing of the valves.

With steam turbine equipment 28-inch vacuum is usually required, it being found advisable to carry a considerably

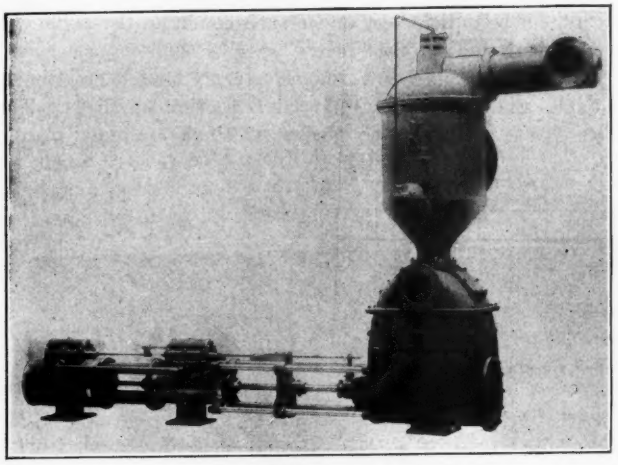


Fig. 3

higher vacuum than is economical or customary in connection with the reciprocating engine. The connection between the turbine and condenser is made as short and straight as possible, as the turbine exhausts directly into the jet condenser. The steam enters the side of the con-

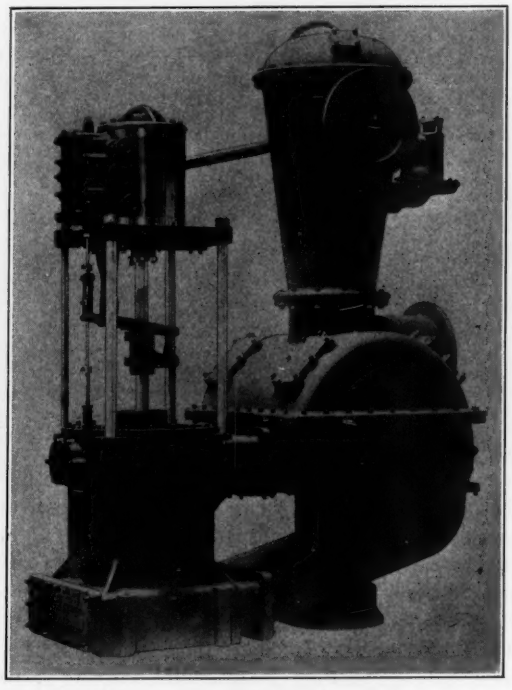


Fig. 4

denser, where it is met by the falling drops of water from the spray plate.

While it is claimed that the steam turbine occupies much less floor space per unit of output than the reciprocating engines, there is not much doubt that they require considerably larger space for the auxiliary equipment, as noted by the illustrations, Figs. 1 and 2. In reference to the operation of the condensers of the type shown, it may be stated that the injection of water, together with the condensed steam falls directly into the wet pump which is placed underneath the condenser, this pump being of the direct-acting type, discharging the water into the waste pipe. As this pump is entirely independent, its speed can be regulated according to the amount of water to be handled.

The air and non-condensible vapors entering the condenser pass through the falling spray and are taken up at the point of lowest temperature by the dry-air pump. It is claimed that this method of separation of the air and water, and the withdrawal of each by separate pumps, gives a vacuum as near the barometric indication as can be practically obtained, and is consequently the method most generally used in practice.

Strength of Aluminum.

The tensile, crushing and transverse strength of aluminum varies considerably with different conditions of hardness, due to cold working; also to the amount of work that has been put upon the metal and character of the section, and the amount of hardening ingredients. Cast aluminum is about equal in strength to cast iron in tension, while under compression it is comparatively weak. Taking the metal 99 per cent. pure, the ultimate tensile strength per square inch in castings is 18,000 pounds, in sheet, 24,000 to 40,000; wire, 30,000 to 55,000 pounds, and bars, 28,000 to 40,000 pounds. As compared with copper, the average tensile strength of which per square inch is authoritatively stated to be as follows: Cast, 19,000 pounds; sheet, 30,000; bolts, 36,000, and wire, 16,500, pure aluminum compares with copper in the same manner that alloyed aluminum compares with brass. The elastic limit of 99 per cent. pure aluminum is for castings in tension 8500 pounds; sheet, 12,500 to 25,000; wire, 16,000 to 33,000; bars, 14,000 to 23,000 pounds per square inch.

Under transverse tests aluminum is not very rigid, although the metal will bend nearly double before breaking, while cast iron, under similar conditions, is broken very easily. The tensile strength of aluminum is greatly improved by subjecting the ingots to forging and pressing at a temperature of 600 degrees Fahrenheit. Taking the tensile strength of pure aluminum in relation to its weight, it is as strong as steel of 80,000 pounds per square inch. Aluminum properly alloyed with nickel is much stronger than the pure metal, as may be seen by the following figures: Nickel-aluminum has an ultimate strength per square inch tension in the form of castings of 18,000 to 28,000 pounds; in the form of sheet, of 35,000 to 50,000, and in bars, 30,000 to 45,000.

The elastic limit in tension per square inch of nickel-aluminum is as follows: In castings, 8500 to 12,000 pounds; sheet, 21,000 to 30,000, and bars, 18,500 to 25,000. The average tensile strength of brass when cast is 18,000 pounds per square inch; when in the form of wire, 49,000 pounds. Bronze or gun-metal has an average tensile strength of 36,000 pounds per square inch.

A HIGH TENSION D. C. INTERURBAN TROLLEY ROAD

1200 Volt System of the Indianapolis & Louisville Traction Company

Operating electric railways with direct current transmitted at 1200 volts pressure is, at the present time, of special interest, owing to the absence of the high tension wiring and sub-stations. The first road to operate its line on this plan, is the Indianapolis & Louisville Traction Company. This system but as will be anticipated, under such condition the voltage is poor at both ends of the line.

The car-barns and power-house are erected at Scottsburg, Indiana, and both are substantial red brick buildings. The power-house contains two horizontal single-cyclinder Corliss

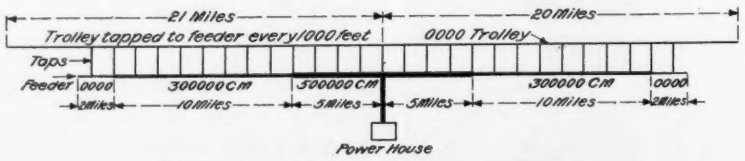
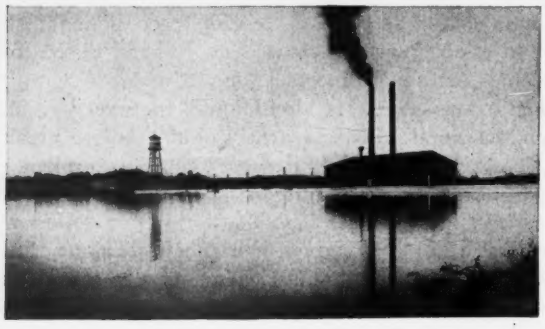


Diagram Showing Arrangement of Feeders

is forty-one miles long, connecting Seymour, the southern terminus of the Indianapolis, Columbus & Southern Traction Company, with Sellersburg, the northern terminus of the Louisville & Northern Railway & Lighting Company. The power-house is located at Scottsburg, being about the center of the route. The feeding pressure at the power station is 1,200 volts between the single No. 0000 grooved trolley and the rails. Each heavy duty non-condensing engine running at 120 revolutions per minute drives two 300-kilowatt, 600-volt generators in pairs with armatures mounted, commutator to commutator on the engine shaft, the combined output being at 1,200 volts. In addition to operating its cars at this pressure, the company maintains a line from Sellersburg to Louisville, a distance of fourteen miles, at 600 volts pressure; consequently cars are being run over sections of trolley fed by both 1,200 and 600-volt current.



Power House of the Indianapolis & Louisville Traction Co.

The length of the road at present in operation is a little over forty miles, and the most noticeable feature of the line construction throughout is that it differs in no single respect from a well equipped 600 volt D. C. road. The trolley, which is of the 0000 capacity, is supported by a bracket construction and the feeders are arranged as shown in the accompanying diagram.

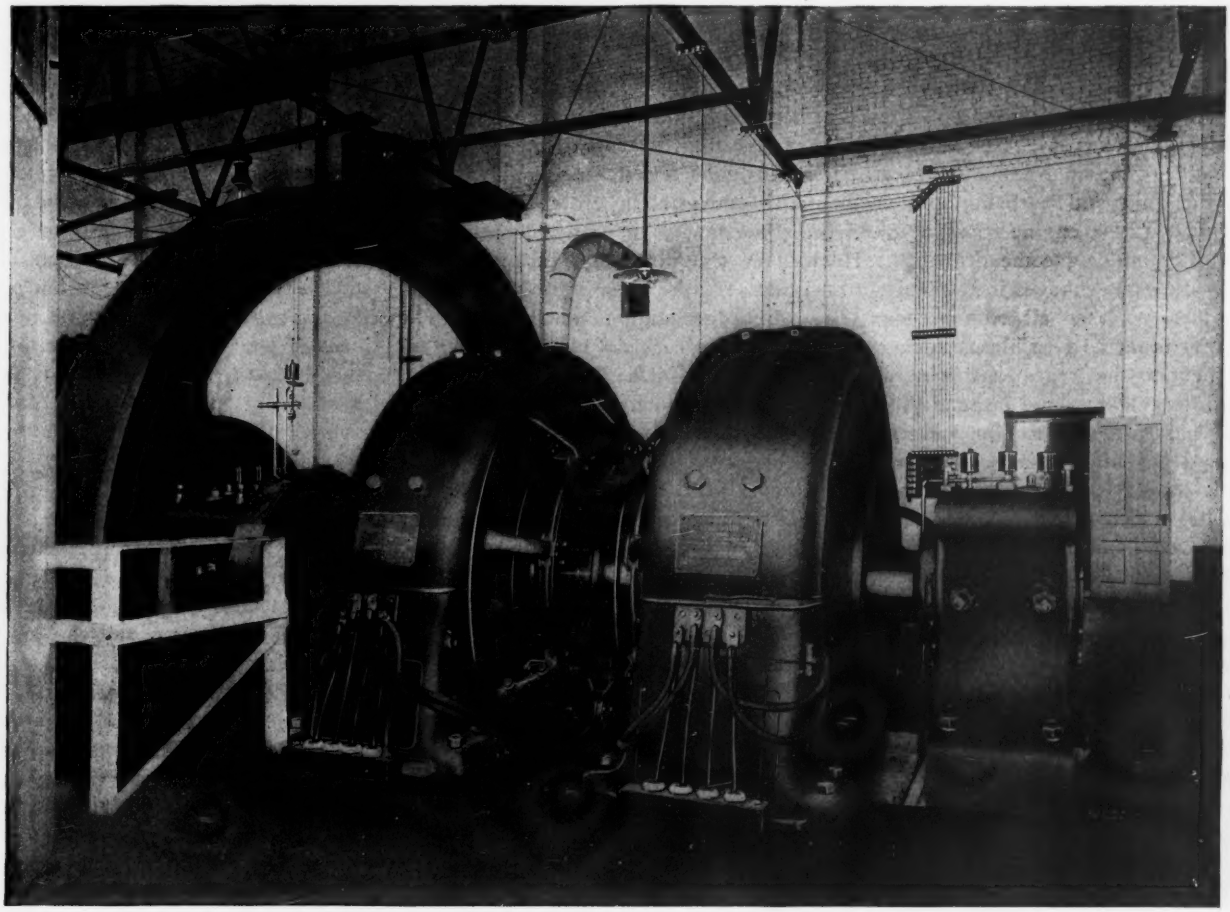
It will be noticed that the power-house is situated in a central position and that the feeders extend for a distance of approximately twenty miles in each direction. It is possible to operate the road for its entire length at 600 volts pressure, engines rated at 750 H. P. each, coupled to four General Electric 600 volts compound wound generators. Two generators are mounted on the extended shaft of each engine, and the windings are connected in series in order to be additive and to give 1,200 volts. The fields are also connected in series on the grounded side. The boiler equipment consists of four Babcock & Wilcox water tube boilers, each rated at 300 H. P. and working at a steam pressure of 160 pounds per square inch. The switchboard consists of two generator panels, two feeder panels and two equalizer panels, all of which were supplied by the General Electric Company.

The car-barn is 173 feet 4 inches long and 69 feet 10 inches broad. It is provided with four parallel tracks and four wheel pits each 55 feet in length, and has more than sufficient capacity for holding the present equipment, which consists of eight 50-foot passenger cars and two express cars. One end of the car-barn is fitted up as a workshop, being equipped with lathes, drills, forges and other appliances which are sufficient, not only to maintain the cars when once in operation, but to do all the work incident to installing the electrical equipment in the first place. The offices of the master mechanic, train dispatcher and secretary and treasurer of the line are also under the same roof as the car-barn.

According to the *General Electric Review*, the greatest interest will undoubtedly be centered in the electrical equipment of the cars, as the arrangements are such as to permit their operating on both 600 and 1,200 volts D. C. Each car is equipped with four motors, which are commutating pole machines and have a capacity of 75 H. P. each. These motors are connected in two pairs, each pair consisting of two motors in series, so that the voltage across the terminals of each individually never exceeds 600. The fields and armatures are provided with extra insulation as a safeguard against any momentarily high values of voltage should any pair of wheels skid or slip during operation. The control circuits proper are operated by current at 600 volts, the high tension of the trolley being reduced or transformed by means of a dynamotor. This dynamotor works on the same principle as the auto transformer, or perhaps it may be more clearly described as a motor generator with both windings wound on the same core and in the same slots. It is provided with a commutator at each end. The 600 volts for operating the control circuit when the car

is running on 1,200 volts is obtained by the dynamotor as follows:

The trolley is connected to one set of brushes on the first commutator, the other set of brushes on commutator No. 1 being connected to a set on commutator No. 2, while the remaining set of brushes on commutator No. 2 are grounded. As one set of windings is always generating while the other set is motoring, it is obvious that the potential across the brushes of commutator No. 2 will be half of the applied voltage, namely, 600 volts. The 600-volt current obtained in this manner is not only used to energize the contractor coils, but also to operate all the auxiliaries. The dynamotor has a rated capacity of 12 kilowatts.



Generators of Indianapolis & Louisville Traction Co , Scottsburg, Ind.

The motors are provided with commutating poles and as this is the first instance of a direct current commutating pole railway motor being placed in service to operate at 1,200 volts, the most essential features may be of interest. The motor is of the box frame type. The commutating poles are situated midway between the exciting poles and have their windings all connected in series with one another and with the armature. The function of these commutating poles and their operation may best be understood by considering an imaginary view of the armature with two poles developed to form a flat surface. In such a diagram there will be a broad sheet of current flowing in the armature in the direction of the motor shaft under one pole, and in the reverse direction under the other pole. This sheet or band of current produces a magnetic field of its own which is opposed to the main flux of the field poles and changes the distribution of this main exciting flux. Not to enter too much into detail, the principal effect of this distortion may be stated as the formation of a strong magnetic field midway between the N. and S. pole of the motor, which field has the harmful effect of producing a local current in the armature conductors at the very instant when their current is being commutated and reversed by passing from the influence of one field to that of another. Or, in other words, the magnetizing effect of the armature is at its maximum value midway between the poles, and it is the cutting of this field that produces a local voltage and causes sparking at the commutator. The function of the commutating pole is to produce a field of equal strength and in an opposite direction to this magnetizing force produced midway between the exciting poles, and thus to counteract or wipe out the magnetic field which causes local currents at the point of commutation, and consequently to eliminate sparking.

The fact that the commutating poles are connected in series with the armature insures their magnetic strength varying in accordance with the strength of the armature current when operating on fluctuating loads. There are other minor factors which enter into this consideration, but the above will show the fundamental principles.

The practical benefits derived by the use of commutating

motors may be summarized as follows: With the elimination of sparking the etching of the commutating bars will be materially reduced, and as the carbon brushes are required to carry only the line current and no local current, they will wear better and disintegration will be materially reduced. The outcome of this will be that the commutator bars will wear less rapidly and there will not be so much high mica to be worn down, with the result that a car will be able to make a greater number of car miles before its being necessary to send it to the carn-barn for repairs.

The lack of sparking will further permit the use of higher voltages between commutator bars and consequently greater trolley voltages, which means that it is now practical to operate a D. C. road of 1,200 volts for double the distance between sub-stations.

A TALK WITH A CHIEF ENGINEER

Some Practical Pointers About Piping, Burning Ashes, Hydraulic and Electric Elevators and Superheated Steam

By William Kavanagh.

Talk No. 7.

The utilization of ashes as a source of heat or the possibility that ashes might be used in some way, so that heat could be generated from them, caused me to make a call on the Chief and learn his opinion about this matter. On arriving at the engine room, I found the Chief busily engaged in making some drawings. He said he was about to make some changes in the piping conveying steam to the engines, so that all elbows, tees, etc. would be eliminated, as far as possible, replacing them with pipes curved or bent to the largest radius permissible. In this way, he said, the steam could be made to flow to the engines with the least possible friction, and at the same time the bends would partially act as expansion joints, which in a measure, would prevent the leakage inevitable with rigid joints. The Chief pointed out to me how the braces held each connection rigid, thus preventing the piping from expanding and contracting, and causing numerous leaks to appear at the flanged unions and tees. I suggested to the Chief that the proposed changes would take considerable time and money, but the Chief said that he proposed to make the changes gradual, and not rush matters.

"You see," said the Chief, "the smallest engine calls for a three-inch pipe. I am going to take measurements for each curve separately, to suit the dimensions I have drawn, so that when the bend is connected, the pipe covered, and old fittings removed, I will be in a position to go ahead with the next engine. In this way I am going to get rid of all right-angle bends and cut down the operating expenses. With the present system of piping, my assistants are continually tightening bolts on the flanged ells and unions and in most cases, new gaskets must be inserted; so when the bends are finished, I will be able to cut out most of these small jobs and consquently effect a saving in overtime, as most of the repairs must be made on Sundays."

At this point, I asked the Chief his opinion about the burning of ashes and the great results which were to be derived from its use as a source of heat generation. The Chief answered this question by saying: "I have seen considerable matter published in the daily papers on this subject, but I paid very little attention to it, with the exception that I noticed how a decided humbug could obtain such a tremendous amount of free advertising. Why," said the Chief, "it would cost you one hundred thousand dollars to advertise a legitimate article and have it receive the same amount of publicity. Of course you have noticed how the daily papers publish, from time to time, the most laughable articles on mechanical subjects. In reference to the burning of ashes, let me say that you cannot burn anything that is a product of combustion, and ashes is one of those products. We often read, or hear, about some one who has discovered means by which the air and water can be burned, but like the ashes, these are non-combustible. If either air or water could be burned, life on this planet would be dependent upon the whim of any person not satisfied with his mode of existence; hence for humanity's sake, it is a very good thing that neither air nor water can be burned."

During this conversation, Kingsley came into the engine-room, and, after being seated, he pulled out a paper which gave the opinion of one hundred chief engineers on the relative merits between hydraulic and electric elevators, and also which elevator was the safest and most economical to operate. Of the one hundred opinions, eighty were in favor of the hydraulic elevator, and only twenty in favor of the electric elevator. Kingsley read some of the various opinions of the chief engineers as regards the two types of elevators, and after he had finished, he asked the Chief to express his opinion on the subject. The Chief replied by asking Kingsley which type of elevator he favored, and Kingsley replied that he favored the hydraulic elevator for the following reasons: The hydraulic elevator is safer, more rapid and can carry more than the electric elevator; besides when the hydraulic elevator is at rest no power is used, whereas with the electric elevator, current must be at all times generated, whether the elevator is in motion or at rest. There is also danger of burning out an armature, thus preventing the use of the elevator until repairs are made or a new one installed. Kingsley said that the points he had just mentioned were sufficient to convince him that the hydraulic elevator was in every way superior to the electric elevator.

"Well, Kingsley," said the Chief, "I am sorry that I cannot agree with you, but I think that the electric elevator is in every way superior to the hydraulic elevator, for the following reasons: The electric elevator is cheaper to install, it occupies less space, it is as fast, if not faster, than the hydraulic elevator, and without a doubt the elec-

tric elevator is a safer machine to carry passengers or freight. The dangers that accompany the hydraulic elevator are not present with the electric machine, and therefore need not be mentioned."

As Kingsley wanted to know what dangers were present with the hydralic elevator, the Chief replied, "You know, Kingsley, the two greatest dangers are loss of water and presence of air in the operating cylinder." In explaining the effects of an air-bound cylinder, the Chief said: "When the hydraulic elevator becomes air-bound, the car is sometimes wrecked, and in some cases loss of life occurs. This is impossible with the electric elevator."

"When the electric elevator is at rest, no power is used, whereas, with the hydraulic, steam must be maintained constantly at the throttle during the running hours of the elevator. This steam condenses, requiring a fresh supply and the condensation must be carried away by means of traps or drips; besides there is always a chance of leakage, which destroys the steadiness of the car when stopped at any particular floor. There is no such thing as "creeping" with an electric elevator.

"The burning out of an armature is a poor argument to advance against the electric elevator, because you might as well say that the pressure tanks of the hydraulic system might burst, which, by the way, has happened in several cases. If you make a comparison of the amount of work required to maintain the two types of elevators in running condition, you will find that the electric elevator requires the least amount."

Kingsley, however, was not satisfied with these arguments, and stoutly argued in opposition to them, saying, that he thought it was impossible for twenty men to be correct and eighty men wrong. The only way Kingsley could personally uphold his argument, was by saying that the electric elevators at his mill could not carry the same load as the hydaulic elevators, to which the Chief replied that the electric elevators were not constructed to carry such havy loads. "If I were compelled to select a type of hydraulic elevator," said the Chief, "it would be of the standard plunger pattern, as I firmly believe that this type is superior to other types of hydraulic elevators."

After this discussion, the conversation switched off to the subject of superheaters. The company that owned the mill where Kingsley works, were about to install superheaters, and he said he understood that the superheaters were to be connected in such a way that the hot gases from the furnace would strike them, and that he did not understand why steam could not be superheated directly in the steam boiler. The Chief here remarked that he would give Kingsley all the information that he would ever need to know about superheaters and superheated steam.

"You know, Kingsley," said the Chief, "steam cannot be superheated while in contact with water, for the reason that if water is present, saturated steam will continue to be generated, and it is therefore impossible to raise the temperature of the steam or to superheat it, while in contact with the water. Steam that is generated in a boiler is called saturated steam, and to superheat it, it must be led away from the body of the water in the boiler to the superheater, from which it is led to the engines or for whatever purpose superheated steam is needed. Many builders of superheaters connect them in some particular part of the boiler furnace or uptake, while other builders of superheaters construct them after the manner of an auxiliary boiler, which is fired in the same way as the regular boiler.

"When a superheater of the auxiliary boiler type is employed, it is operated in the following manner: The superheater is filled with water to about the first or second gauge and steam is raised on the superheater to a pressure equal to the pressure to be carried on the main boilers. After steam is generated on these boilers, it is allowed to flow to the superheater; then all the water in the superheater is blown out, the blow-off is closed and the superheater is fired in the usual way. Steam traps are connected to the base of the superheater in order to drain off any moisture that might collect from condensation or otherwise.

"When a superheater is connected in the furnace of the main boiler, it is first filled with water, and is in communication with the boiler. When steam is raised, the water connection between the superheater and main boiler is closed and the water is blown out of the superheater. Steam is then admitted to the superheater and raised in temperature.

"Another method often employed to superheat steam, is to pass the steam through a series of tubes that are situated within another boiler, the pressure of which is considerably higher than that carried on the main boilers. The steam in flowing through the tubes is elevated in temperature by reason of the incrased heat due to the higher pressure, and the water in the steam is evaporated and the steam becomes dry and superheated. The principle object of superheating steam is to eleminate all the moisture possible, which will prevent cylinder condensation. The exhaust steam, in passing out from the cylinder, robs it of some heat and, of course, the fresh steam on entering the cylinder must first raise the temperature of the cylinder walls before it does any work.

"Superheated steam has its good and bad points, the principle good points being to prevent condensation of the steam and to maintain the temperature of the working cylinder as high as possible. When steam is superheated above a certain point, it becomes difficult to lubricate the piston and valves and it rapidly destroys the packing in the stuffing-box." The Chief was called away at this point and we agreed to meet next week to hear the Chief continue his instructive talks.

Indisputable.

The value of a developed water-power is stated by Chas. T. Main, mill engineer and architect, of Boston, to be as follows:

"If the power can be run cheaper than steam, the value is that of the power, plus the cost of plant, less depreciation. If it cannot be run as cheaply as steam, considering its cost, etc., the value of the power itself is nothing, but the value of the plant is such a sum as could be paid for it now, which would bring the total cost of running down to the cost of steam power, less depreciation. That is, it is worth just what can be gotten out of the plant and no more." So there!

EXPERIENCE WITH THE HATCHET PLANIMETER

Method of Construction and Calibration

By C. N. Lewis.

I noticed in the last issue that two of your readers were interested in the hatchet planimeter, and, with your permission, I would like to give them, and others interested, the benefit of my experience with the little instrument.

To make it, take 15 inches of 1-16″ steel wire and heat and hammer the hatchet end at least 5-16″ wide, as shown in sketch. Round this edge nicely and make it conform to the circumference of a penny, leaving the edge about as sharp as a table knife. Smooth and burnish it so it will work easily; this is quite important. Now taper the other end as illustrated, and bring the point down to about 1-64″ and round and smooth it so it will not scratch. This fine point is necessary for accurate work. Now bend the wire as illustrated and adjust the hatchet until it will be in line with tracing point. Smooth and finish the instrument all over with fine sandpaper, and if all the work has been properly done, you will have a little instrument hard to beat.

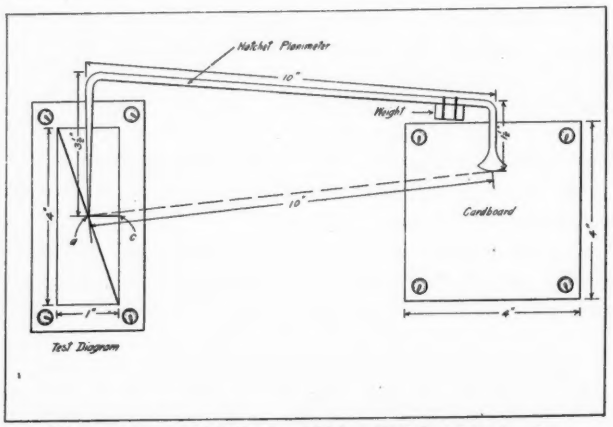
A weight is needed on the hatchet end to hold it to its work when in use. It can be made as follows: Make a mould 1¾″ long, 1¼″ in width and 1″ in depth. Saw out a groove in the mould cover so the planimeter will just press in flush. Now take two thin strips of brass ¼″ wide and 1½″ long and tin each end for about ½″ with soldering copper. Bend them evenly and nicely around planimeter, as illustrated, and press in groove. Now fasten on cover with planimeter in place and putty up all seams. Melt the composition for your weight—mine is Britannia—and pour at bottom of mould.

After finishing and polishing, the instrument should be tested and I advise you to draw a diagram as illustrated, and be careful to draw it as perfect as possible. Fasten it with thumb-tacks to a board about 14″ long and 8″ wide, and with pencil make a dot at *a* and draw a line from *a* to *c*. The center of the diagram should be the starting point and ending point.

Fasten with tacks, as illustrated, a piece of card-board for the hatchet end and place the tracing point of your planimeter on *a* and the hatchet end a little to the right of the center. Press the hatchet end just enough to make an impression in the card-board. Now take hold of tracer end lightly with thumb and finger and move it down to *c*, then to *a* and around the diagram back to *c*, then to *a* again and make another impression with the hatchet. These two impressions represent the travel of the planimeter in passing around an area of 4 square inches, and if measured by a 50-scale, would be just 20 points, so that 5 points represent a square inch when measured with this scale.

To again verify the reading of the planimeter, return the planimeter to starting point *a*, make your impression, and move down to *c*, then to *d*, then across the diagonal *d f*, then to *g* and back to *c* and *a* again. Make impression and measure travel. You will find that if measured with a 50-scale, the hatchet will have moved 10 points, and therefore the tracer will have encircled 2 square inches. It must be remembered that in using a 50-scale, 5 points represent a square inch; a 60-scale, 6 points; a 40-scale, 4 points; and so on, but for a beginner a 50-scale will be the best to start with.

Now if after tracing your 4 square inch diagram, you find that you get a little more than 20 points, something will be wrong somewhere, and you will have to try it over again carefully, keeping tracer on lines. Should it come too large again, spread out tracer point 1-16″ and try again, until you get it right. Lengthening the planimeter will shorten its travel and shortening the planimeter will lengthen its travel, and when you get it right, you will have an instrument that will please you and excite your admiration.



Dimensions and Methods of Using Hatchet Planimeter

When finding the area of an indicator card, begin and end in center, as I have shown. If you used a 60-pound spring in taking the card, you will need to measure your planimeter work with a 60-scale.

To get the mean effective pressure, mutiply the travel of the planimeter by 10 and divide by the length of the card, and to get the area divide by the scale. To illustrate, suppose the instrument has traveled 33 points and the card was made with a 60-pound spring, then $33 \times 10 = 330 \div 60 = 5\frac{1}{2}$ square inches area and $33 \times 10 \div 3\frac{1}{2}$ (length of card) $= 94$ pounds mean effective pressure.

If you find that in using your planimeter it works a trifle hard on the card board, rub the card lightly with a piece of dry ivory soap and your troubles will be ended.

The best coal on the Pacific Coast, south of Washington, has recently been found at Stone Canyon, Monterey County, California. The bed is about 15 feet thick and has been traced for several miles. Analysis of the coal shows that it is a good gas making coal of excellent heating power. It contains little moisture, but considerable sulphur. The coal is hard and does not slake, so that it should stand transportation well.

ENGINEERING IN A NUTSHELL

Answers to Questions That Won First Prize in the Michigan N. A. S. E. Contest

By Edward J. Rose.

Subject No. 13—Superheated Steam.

Superheated steam is made by drawing steam from the boiler and heating it after it has ceased to be in contact with the water in the boiler. The apparatus by which the extra heat is imparted is called a superheater. The steam is conducted through the pipes, and hot air and gases of combustion are passed around the outside of them, thus raising the temperature and forming a more perfect gas.

So far, the most effective method of reducing cylinder losses by condensation, is that of superheating the steam before it is delivered to the engine. An advantage incidentally obtained in most cases where superheating is adopted, follows from the reduced demand for steam on the boilers. Fewer boilers may, in many cases, be used; the result generally being that the efficiency of the boilers is also increased.

In condensing engines a still further advantage is derived from the fact that the use of superheated steam reduces the work done by the air pumps, feed pumps and circulating pumps.

Water around the piston and valves, causes much leakage. By using superheated steam, most of this leakage is prevented. During superheating, although the pressure of the steam remains constant, its volume is greatly increased. The amount of heat required to superheat one pound of steam 150 degrees F., is 72 British heat units.

Experience has shown that the best results cannot be obtained unless the gases reach the superheater at a temperature of at least 1,000 degrees F. This cannot well be accomplished with the waste gases from steam boilers unless the gases leave the boiler surfaces at a higher temperature than is consistent with the best economy.

The temperature necessary for efficient chimney draught is between 500 degrees and 600 degrees F., and good boiler design should not permit the gases to escape at a temperature high enough to be most effective for purposes of superheating.

Subject No. 14—Steam Heating, Both Vacuum and Gravity.

In ordinary practice the exhaust steam is turned into a special tank proportioned to the work to be done, and this tank is connected direct to the boiler with reducing valve between, so as to maintain a uniform pressure.

The distributing mains are carried to the top of the building, sometimes in several pipes, but generally in a single pipe. They are then distributed in an attic between the top story and roof horizontally, and downward mains are carried and connected at the different stories with radiators. The steam and water of condensation travel in the same direction. The return pipes are connected in the radiators and carried below the basement ceiling to a receiving tank below the water level, where the boiler feed pumps pump the water of condensation back from these receiving tanks to the boiler. Very frequently the feed water heater and receiver are made in one. This system is very simple, as are most all gravity systems.

In the vacuum system, as originally installed, under the now expired William's patents, the return lines were carried independent of each other to a horizontal receiver or condenser that connected into the suction of the vacuum pump. This receiver or condenser was usually formed by using a section of four or six inch pipe sufficiently long to allow all these return lines being connected into it. A cold water pipe passed through its center with its end plugged and small holes drilled in it opposite the ends of the return lines for condensing the steam that was drawn through with the water from the system. A globe valve in each line near this condenser allowed an attempt to control the draught on each line, and prevent too much steam drawing through with the water of condensation. This system accomplished the result it was designed for, that is, reducing the back pressure on the engine when exhaust from such was used for heating. The suction on the return lines caused a partial vacuum in the condenser, thus pulling the air and water from the system instead of hav- to push it out by additional pressure at the inlet. This arrangement gave a better circulation throughout the heating system than is possible with the gravity system.

This crude vacuum system demonstrated the possible results of the principle, but is too extravagant in the use of steam to be practical. In cases where there is not an abundance of exhaust steam, this principle of using a partial vacuum to secure a circulation in the system by pulling on the discharging end of same, instead of pushing on the inlet end, has been followed in the more modern practice. Automatic valves have been devised that reduce the amount of steam blown through into the vacuum line. Each unit of radiation has its own automatic valve and return lines from each join in one main return line to vacuum pump.

The only practical difference in the vacuum systems, is the automatic valves used; each manufacturer of such a system having his own valve for the purpose.

It is often said that if we use steam at the pressure of the atmosphere and a temperature corresponding, we must provide more radiation than necessary with the gravity system, where a pressure of two to six pounds is used. Now, if all other conditions were the same, this would be the case, but owing to the vacuum system being at all times free of air and water, every square inch of radiating surface is heating surface, while with the gravity system it is impossible to secure this condition, on account of air and water binding, and some part of the radiation is not giving off its heat.

The additional advantages of vacuum systems are, doing away with all air valves, reducing back pressure on engine when exhaust is used, securing a system free from water hammer or cracking in steam pipes, every square inch of

radiating surface is made heating surface, no air or water binding, and on account of the smaller mains, the cost of installing is reduced.

SUBJECT NO. 15—ECONOMY IN THE USE OF AUTOMATIC STOKERS, OVER HAND FIRING.

There is considerable difference of opinion in regard to the comparative merits of hand firing or mechanical stokers, for the reason that even with the automatic stoker, we cannot dispense with manual labor in the fire room. At present the machine fed fire needs a great deal of attention. This is particularly the case with the coking coals which are used in many plants. There are some cases where a first-class fireman can get results which the brainless machine cannot, but this first-class fireman, by the very reason of having brains, only fires until a better job gets him.

Out of the large number of mechanical stokers on the market, we can put them in two classes; the under-feed, which cannot be used without forced draft, and the over-feed, which can be used with natural draft if desired. Now, the ideal stoker is the one that can introduce small quantities of coal without, at the same time, admitting large quantities of air over the fire.

The operative advantages to be expected from the substitution of hand firing for mechanical stoking, are, lower cost of firing, greater uniformity in conditions of fires and operation, readiness for burning all grades of fuel and less production of smoke. Every practical fireman knows the effects of a thick green fire on a hot bed of coal as witnessed by the immediate belching of smoke from the stack. This is due to the sudden liberation of volumes of gas from the body of fresh coal accompanied by a lowering of temperature, caused partly by the fresh coal itself and partly by the necessary opening of doors in firing. To this there is no alternative in hand firing, as frequent hand firing in small quantities means frequent opening of the fire doors and causes injury to the boiler from unequal contraction and expansion. In the proper mechanical stoking the furnace is never open to the outside air, so its temperature is always high and uniform.

In connection with a large battery of boilers, its economy will partially appear in the saving of labor, not only the labor of firing, but by means of elevators and conveyors, which are possible with most mechanical stokers, and the labor of handling the ashes as well. With every boiler, whether single or in batteries, the economy will also appear in the efficient burning of slack yard screenings and cheap fuels generally. The money saved in the cost of lower grades of fuel depends of course upon the locality. Coal slack is seldom less than 30 per cent. and often 50 per cent. cheaper than screened lump or run of mine of the same quality. Many attempts have been made to substitute it in connection with hand firing. It is found in practice, that in attempting to burn slack on a flat grate, it cakes into a close mass, shutting off the air supply and yielding volumes of smoke, but little heat. It can, therefore, only be burned by frequent slicing and cleaning. The cost of labor and heat lost from constant opening of the fire doors generally offsets the saving in the cost per ton of the fuel.

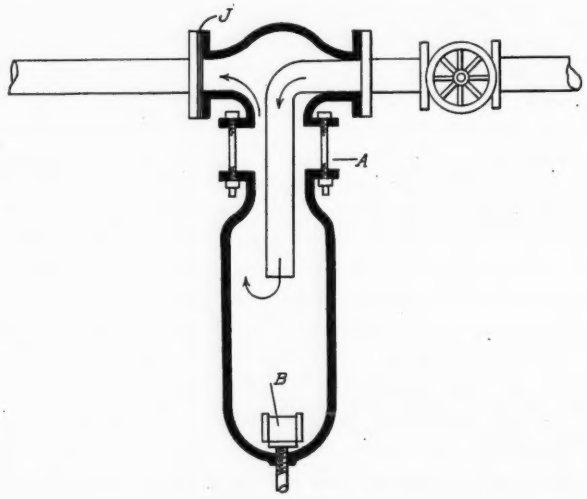
The mechanical stoker burns slack equally as well as screened lump. In burning slack in the stoker the body of the fire is uniform in thickness, while the caking is constantly broken up by the mechanical movement of the stoker. However, skilled hand-firing, for a short run, will equal mechanical stoking in efficiency, but for day in and day out, with a given grade of fuel, the mechanical stoker will get much the best results out of a pound of coal.

So in summing up, the modern automatic stoker has many advantages over hand-firing, and it must be admitted that the mechanical stoker is a most desirable addition to power plants, where very low grades of fuel are burned. And even if there was no commercial advantage, the introduction of the mechanical stoker should be advocated for the reason that it supersedes one of the most fatiguing and dirty kinds of work; that few but the operating engineer can realize. So labor saving machinery, which relieves human beings from the stoking of boilers, should be welcomed.

The Force of Steam Currents in a Separator.

BY J. O. FRAZIER.

My letter in the January issue in reference to "Steam Separators" recalls an interesting incident illustrating the force of moving currents of steam in steam separators, which may be interesting to mention while discussing the importance of this type of apparatus.



A separator was hurriedly moved one Sunday from a location in the exhaust system of the plant to a high pressure line of piping. As it was formerly placed in an isolated corner, a small leak in flange joint A did not have the importance or the magnitude that it would probably have in the live steam line, where everybody would be bothered with the leak, so it was determined to repair it. The separator was hoisted in position with chain blocks, and the joint opened with some long threaded bolts, as shown at A, and was afterwards closed up in the same way.

During the rush in making things up, one of the boys dropped one of the ¾" nuts belonging to one of the joint bolts, into the body of the separator. As time was precious and starting time was close at hand, it was decided to

leave the nut in the separator, because, if water would lie in the bottom, surely a big nut would, without being picked up with the steam currents. I felt rather proud, then, of having placed a tee in the interior of the separator as shown at B, for the nut couldn't stop up both ends of the tee and interfere with the drainage, which was the difficulty most to be feared.

After starting, I stood by the separator wondering if it was possible for the nut to get picked up and be carried into the main leading to the engine, and get into the throttling governor and give us a runaway engine. In less than twenty minutes, there was a rattling sound, and I imagined I could trace the travel of the nut to the top of the separator and back again to the bottom. This frightened me, and I immediately stationed a man at the engine to control it in case the nut did go over.

As it was quite a job to take the separator down, I was determined to use some other means of relief. Each morning we stopped for about forty-five minutes to "wash-down" the sugar mill to prevent sourness, and, at the first stop, I put a wire gasket between two joints in the flange at J, which would catch the nut if it reached that point.

After the close of the season, which was about seventy-five days later, the nut was found in the separator with the corners considerably chafed, apparently having made many trips, several of which were heard. This incident strengthened what has always been, on my part, a strong disposition to protect all practicable points against every imaginable contingency, on the general principle that it is the unexpected which happens. I have never been sorry for any efforts that I have put forth in that direction, even though they didn't show immediate results.

This experience emphasizes the fact that it is very desirable to completely isolate the water collected by a separator from the currents of steam, or to immediately remove it. Isolation in this instance would have prevented the ascent of the nut.

Producer Gas.

Producer gas is the gas produced by converting incandescent fuel entirely into gas and ashes in the presence of steam and a limited supply of air. The gas is the result of the incomplete combustion of the fuel, and consequently the gas drawn from the producer is ready for combustion as soon as air is admitted to create a combustible mixture, as in an engine cylinder.

The use of steam serves several purposes: it cools the grate, it enriches the gas, it keeps the temperature of the fuel bed at such a point as to prevent the formation of large clinkers, and it adds to the efficiency of the producer by giving off hydrogen, which forms a valuable constituent of the producer gas.

A typical analysis of our producer gas is as follows:

Carbon dioxide	(CO_2)	5.0%	Hydrogen	(H_2)	14.0%
Oxygen	(O_2)	.2%	Marsh Gas	(CH_4)	.8%
Carbon monoxide	(CO)	26.0%	Nitrogen	(N_2)	54.0%

Suction producer gas is made in a gas producer by the suction of a producer gas engine drawing a mixture of air and steam through the incandescent bed of fuel, in the brick-lined generator of the producer; the gas thus made passes through a cooling and cleaning aparatus before it reaches the engine. The steam necessary to make the producer gas is raised automatically in the plant itself in a vaporizer by the hot gases passing from the generator on their way to the cooling and cleaning aparatus.

The Production and Value of Petroleum in the United States.

According to a recent bulletin issued by the United States Geological Survey Bureau, the production of petroleum in the United States during the year 1906 was 126,493,936 barrels, having a total value of $92,444,735.

This output was furnished by the five great fields, as follows: Appalachian field, 27,741,472 barrels; Lima-Indiana-Ilinois field, 21,951,711 barrels; Mid-Continent field, 21,718,648 barrels; Gulf field, 21,645,425 barrels; California field, 33,098,598 barrels, and from scattered States and areas, chiefly Colorado and Wyoming, 338,082 barrels.

The State production is shown in the following table:

QUALITY AND VALUE OF CRUDE PETROLEUM PRODUCED IN THE UNITED STATES IN 1906, BY STATES.

State.	Quantity. Barrels.	Value.	Average price per Barrel.
California	33,098,598	$9,553,430	$0.289
Colorado	327,582	262,675	.802
Illinois	4,397,050	3,274,818	.745
Indiana	7,673,477	6,770,066	.882
Indian Ter., Oklahoma & Kansas	21,718,648	9,615,198	.443
Kentucky and Tennessee	1,213,548	1,031,629	.850
Louisiana	9,077,528	3,557,838	.392
Michigan and Missouri	3,500	4,890	1.397
New York	1,243,517	1,995,377	1.605
Ohio	14,787,763	16,997,000	1.149
Pennsylvania	10,256,893	16,596,943	1.618
Texas	12,567,897	6,565,578	.522
West Virginia	10,120,935	16,170,293	1.598
Wyoming	7,000	49,000	7.000

As to the rank of the various States in the production of petroleum, California furnished nearly one-fourth of the total output and still holds first place as to quantity, and Kansas, Indian Territory and Oklahoma jointly hold second place. Ohio occupies third place, and is followed by Texas, Pennsylvania, West Virginia, Louisiana, Indiana, Illinois, New York, Kentucky, Tennessee, Colorado, Wyoming, Michigan and Missouri, in the order named.

In value of oil produced, Ohio stands first, with Pennsylvania and West Virginia second and third. Kansas, Indian Territory and Oklahoma, jointly, have fourth place, and California fifth. The order of the other producing States in value of output is: Indiana, Texas, Louisiana, Illinois, New York, Kentucky, Tennessee, Colorado, Wyoming, Michigan and Missouri.

The greater part of the oil from the California and Gulf fields is consumed as fuel, but only a small proportion of that produced in other fields is so utilized.

When cleaning the discharge valves of air compressors, the best method is to fill the oil-cups with soap-suds, made of soft soap, which should be fed into the cylinder. The compressor should be run on soap-suds instead of oil for one day each week, care being taken to feed oil for a half hour before shutting down, so that the parts may not be subjected to rust, which is the only danger from soap suds.

The
Practical Engineer

DEVOTED TO THE ECONOMICAL GENERATION AND UTILIZATION OF POWER

PUBLISHED ON THE FIRST OF EACH MONTH AT
46 North Twelfth Street Philadelphia, Pa.

Correspondence solicited, and paid for upon publication. Short articles descriptive of the small problems and difficulties met with in daily engineering practice are especially desirable. Illustrations prepared from pencil sketch.

SUBCRIPTION PRICE, FIFTY CENTS A YEAR in advance to any Post Office, in the United States, Mexico or United States Possessions. One Dollar a year to Canada and other Countries.

Address all communications and make all checks and money orders payable to

The Practical Engineer

46 North Twelfth Street PHILADELPHIA, PA.

The total circulation of The Practical Engineer for the year 1903 was 77,250 copies, an average of 6,437 copies per issue. Total circulation for the year 1904 was 132,000 copies, an average of 11,000 copies per issue. Total circulation for 1905 was 182,500 copies, an average of 15,208 copies per issue. The total circulation for 1906 was 193,440 copies, an average of 16,120 copies per issue.

Any Advertiser is invited to examine our Paid Subscription Lists and Post Office Mailing Receipts at any time.

Entered at Philadelphia Post-office as Second-class Matter

CONTENTS.

The Action of Boiler Draft..... 3
Machinery and Methods Used for Making Pottery.... 5
The Measurement of Power on Three-Phase Circuits.. 7
Cost of Constructing Steam Driven Electric Power Plants 9
Design of Vertical Gas Engine..... 11
Steam Turbine Condensing Equipment..... 14
Power Plant of the Indianapolis and Louisville Traction Co. 16
A Talk With a Chief Engineer..... 18
Experience With the Hatchet Planimeter..... 20
Engineering in a Nutshell..... 21
Force of Steam Currents in a Separator..... 22
Producer Gas 23
Production and Value of Petroleum in the U. S..... 23
Editorials 24-25
Letters from Engineers:
Central Station vs. Private Power Plants..... 26
Remedy for Noisy Valve Gear..... 26-27
Remedy for Stuffing-Box Trouble..... 27
If Engineers Were Owners 27
Second-Class Massachusetts Examination Questions 28
Application of the Bilgram Valve Diagram..... 29
Education and Experience Both Necessary..... 29
Use Reliable Sheet Packing for Gaskets..... 30
Cause of One Boiler Priming More Than Others..... 31
Remedy for Pounding Engine..... 31
The Harder an Engineer Works for His License, the More He Will Appreciate It..... 31
A Crank Repair 32
Old-Time Engineering 32
Compound Engine Calculations 33
Connections for Feed Water Regulators..... 33
Questions and Answers 34-36
New Power-Plant Equipment 36-39

High Voltage Direct-Current Transmission.

The development of any industry is the result of a cycle of ups and downs, during which time many practical difficulties are met with which must be overcome. This has been particularly true of the development of the electric industry. In its earliest days, electricity was generated from an electromagnetic machine in the form of an alternating current, but as the applicaiton and value of a rapidly vibrating current was not then known, many ingenious devices were constructed to straighten out the current so that it would resemble that kind of current which flowed from a battery. As a result we have the direct-current generator with its well-known form of commutator. For years, electrical engineers were content to generate and transmit direct electric current until it was found that for long distances and heavy loads, the cost of the cables were excessive and the loss of power was almost prohibitive. Voltage could not be raised much over 600 volts owing to difficulties of commutation, so that, especially for electric traction, the design of power plant apparatus and equipment fell into a rut. Power plants were erected in the center of distribution and when the load became too heavy, or the loss of transmission too great, another power house was erected some distance away to supply power to the territory adjacent to it. Electrical engineers soon saw that with the rapidly increasing population in large cities and with the increasing length of suburban lines, some other method of generating and transmitting power must be used.

About this time, the advantages of the alternating current became well known and while it became the most favored system for electric lighting, its use for electric traction was very backward owing to the fact that a good alternating current motor had not yet been built. Consequently, a compromise was made between the advantages of alternating current transmission and direct current traction by generating alternating current at the power house, raising this voltage by means of step-up transformers, and transmitting it to its district of application; and by means of step-down transformers and rotary converters, the direct current of proper voltage was obtained for use in the traction motor. All of this was a distinct advance in the problem of saving electric energy but the idealists in electric traction were still not satisfied with this more or less make-shift arrangement.

The next step was the use of high tension alternating current on the motors of the cars, without the intervention of sub-stations containing moving mechanisms. This was made possible by the design of an alternating current motor which would give proper torque on starting the car, which difficulty has ever been the most serious obstacle to the use of an alternating current motor. Several sysetms have been installed, using this method of traction, but it cannot be said to be a howling success for all classes of electric traction, although every indication points, that with better insulation for the high voltage and other protective apparatus, the single-phase alternating current system will meet all the requirements imposed upon it.

The latest, and perhaps the most successful of the movements to increase the voltage of the line without the use of

sub-stations is in the direction of the direct-current, high-voltage system. Recent experiments have shown that it is quite practical to generate and commutate 1200 volts direct-current and 1200 volt motors are being used successfully on several trolley roads in this country. A description of one of these plants as used by the Indianapolis and Louisville Traction Co., is found in another column of this issue, The power plant is situated almost exactly in the center of distribution of the 41 mile trolley road, and 1200 volts are successfully transmitted, this direct-current voltage being utilized by the motors under the cars. Direct current voltage as high as 2000 volts has been used abroad, and the time may not be far distant when this voltage or even higher voltage will be used for interurban electric traction service in this country.

If the earlier inventors had pushed their efforts a little further in the direction of high-voltage direct-current transmission, instead of almost abandoning it as impossible, there might have been a different retrospective view to be had of the troubles encountered and methods used in the past decade of long-distance electric traction.

—o—

Burning Low Grade Fuels.

In the last fifty years, the best engineering talent in the world has devoted its time and thought to reducing the waste of fuel in the generation of steam. Improved furnaces and mechanical stokers of various kinds have been invented and used successfully so that it is now possible to get as much as eighty per cent. efficiency, and even more, from the energy in the coal. This, however, is not often attained, owing to bad design and careless operation, both of which play havoc with economy.

One of the chief causes for poor fuel economy is due to the fact that very little attention is generally paid to the design of the boiler furnace with respect to the kind of fuel used. Most furnaces are constructed to meet the requirements of high grade fuels, and generally work badly when a fuel of poorer grade is encountered. Owing to the higher cost of all grades of good coal, and the prospect in the future that these prices will be still higher, attention must be more closely riveted to the proper burning of the lower grades of fuel. In generating power from cheap coal, the construction of the furnace, the amount of grate surface and the proper draft must be carefully considered.

When the poorer grades of coal are fired, it requires even more intelligence on the part of the fireman than when the higher grades of coal are burnt. The fireman should, therefore, be trained to burn them intelligently, as the methods of firing low grade fuels require special attention. A poor fireman is dear at any price, and quite as disadvantageous to a plant as a poor engineer, but considering that he is taught very little about combustion, and is most generally poorly paid, it is not surprising that such poor results are often obtained from the furnaces of steam boilers.

The mechanical stoker and the use of fire-arches and Dutch ovens have overcome many of the inherent difficulties of burning low grade fuels, and the use of force and induced draft has also added greatly to the efficiency of the furnace. As draft is always necessary to the combustion of any fuel, it is particularly important that the proper amount be secured to obtain the desired results under given conditions. In another column of this issue, Mr. Walter B. Snow, under the title of "The Action of Boiler Draft," shows just how the draft varies with the different kinds of fuel burnt. He also shows clearly in this article how much draft is required to overcome the resistances of the grate, combustion chamber and flue, and how little draft is actually expended in producing air movement.

While the proper conditions of furnace, draft and firing are important, when high grade fuels are used, it is equally important that these conditions be met when the poorer fuels are encountered, or the saving which results from the use of the lower priced fuels may be negative.

—o—

The proper ignition of a gas engine depends upon the correct operation of the igniter, upon the efficient air supply, proper gas supply and proper compression. Premature ignition may be caused by the improper timing of the electric igniter, by leakage of the timing valve, or when a tube igniter is used, it may be due to the fact that the space heated in the tube is too near the cylinder end of the tube. It may also be caused by the cylinder being overheated in spots, due to improper cooling, or to an incandescent mass of carbon, which may be formed in the cylinder.

—o—

Owing to the high speed of turbo-alternators, special means are adopted to muffle the noise produced by the circulation of the air. In several forms of the horizontal type, the generators are enclosed in such a manner that the air is taken in at the sides of the machine, passed through fans, which discharge it over the end connections of the armature coils, thence into the bottom of machine, from where it passes through the ventilating ducts of the core to an opening at the top of the machine.

—o—

Overheating of gas engine cylinders may be due to improper flow of water through the cylinder water jacket, to the water jacket having become coated with scale or to having an accumulation of dirt in it. The temperature of the outflowing water should not be greater than 140 degrees; some makers of gas engines advising that it should be as low as 100 to 120 degrees Fahrenheit.

—o—

Steam was successfully used recently in quenching an oil fire at Petersville, Pa. There are about 30 oil wells in the vicinity of the town, and when one of them caught on fire, the burning oil flowed through the streets. Steam was raised in the boilers of the oil rigs and the inhabitants used it to put out the fire.

—o—

If at first you don't succeed, don't succumb.

LETTERS FROM ENGINEERS

IN ORDER to make this department of THE PRACTICAL ENGINEER as interesting as possible, a moderate rate will be paid by us for all contributions published under this heading. However, we do not assume responsibility for the ideas or opinions expressed. None need hesitate to contribute because of inability to draw or write well. We will redraw or revise whenever necessary—it is the idea we want. New ways of doing old things, criticisms of accepted theories, and general engine-room experiences are especially solicited.

Central Station vs. Private Power Plants

EDITOR THE PRACTICAL ENGINEER:

Every little while someone comes out with the statement that the central station can produce current cheaper than the firm can make it with their private power-plant. This may be true, and undoubtedly is, but because the central station can make electricity cheaper than a private company can, it does not stand that they do, or will, sell it cheaper than what the private plant can make it.

The central station has a monopoly, as a general thing, in the electric lighting field, also supplying power for motor service, and is usually in a position to dictate the terms it will supply power for, and often can convince the private plant owner that they can furnish electricity at a cheaper rate than he himself can make it. Because power can be supplied cheap is no reason that it will be sold at a low rate, as is shown by the prices charged at Niagara Falls, where there are thousands of horse power in electricity generated, and yet even there the kerosene lamp can be seen burning at night in illuminating the home. I was recently told by a resident of the town that the rate is higher than that charged by central stations in other parts of the country where steam is used to generate the current.

One thing which the central station management does not call to the attention of the consumer is the fact that steam will, of necessity, be required during the winter, and that it will cost almost as much to heat the plant with live steam as it would to operate the plant with an engine and use the exhaust steam to heat the different rooms. This is a fact, nevertheless, and can be proven by any one who does not think so. For instance, in a plant in which I was recently employed it was necessary to maintain an even temperature during the night, or at least have the temperature high enough so that the machines would do their work when started up in the morning. During the day the plant was heated by exhaust steam from the engine, while at night live steam was used. We found that it was necessary to have a man on duty during the night and also during the day, and one worked about as hard as the other. The system was not of the best, and if the live steam got down below a pressure of 40 pounds, the room would soon begin to cool off. The only reason that I have ever been able to offer for this was that during the day, with the machinery in operated, the heated air was put in circulation to such an extent that the rooms were well heated, while during the night the center of the room did not receive any heat to speak of and the hot air from the coils rose to the top of the room and stayed there.

If a plant has a steam boiler and engine it is very seldom that it will be a paying proposition to discard them and adopt electricity. The chances are that the plant can produce electricity cheaper than the central station will sell it unless they will make a rate less than two cents per kilowatt hour, and they do not do that very often, and if they did, that rate would not be in force any longer than they were forced to keep it. After the manufacturer has taken out the steam plant, the company is in a position to raise the rates and the manufacturer has no choice but to pay it.

Here is about the way the thing is done. The solicitor gets the ear of the manufacturer and fills it full of facts and figures, on the central station side of the question, and finally convinces him that he is paying considerable more for his power than is necessary, and so in order to permit him to make more money out of his business, they, the central station, will furnish him with current on the sliding rate, at so much per kilowatt hour, the more current that is used the less it will cost to operate the plant. This looks fine to the manufacturer, especially the low cost of the larger amount of current used, which, by the way, is often figured so high above the actual requirements that he will never be able to obtain the benefit, so that he closes the deal and thinks he has accomplished something grand. The mistake is often found later when he comes to pay his bills.

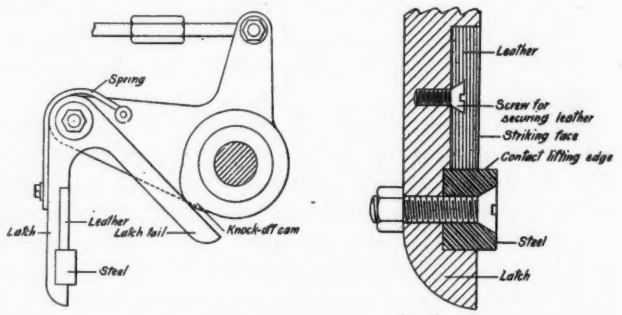
Cleveland, O. E. P.

Remedy For Noisy Valve Gear.

EDITOR THE PRACTICAL ENGINEER:

I note contents of A. C.'s letter which appears on page 34 of the January issue, and in reply would say that I do not think the noise he refers to is caused in the way suggested by him. The latches are fitted with a piece of leather at the surface of contact in order to soften the blow which would otherwise occur if there were no such piece of leather. The leather is secured by a countersunk head machine screw, and the screw is, or should be, let into the leather at least ⅛". The leather should be thick enough to permit the screw being set in to the stated depth.

If for any reason the leather gets pounded down, so that the head of the screw may be brought into contact with



Proper Construction of Latch

the valve arm, or if the leather gets so solid and hard from frequent blows, due to the force exerted by the spring which actuates the latch, there will be a regular "click" sound at every revolution of the engine. It may be possible that one of the latches will get into this condition before

the other; hence the sound at the head end of the gear as stated by A. C.

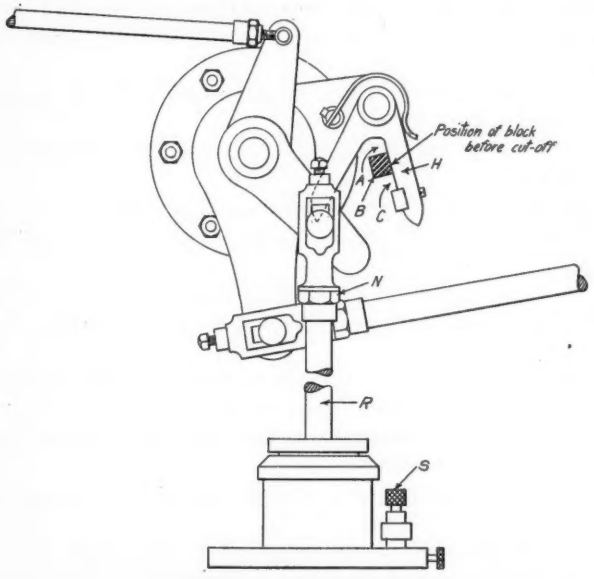
Of course, there may be, and there frequently is, a sound produced by the tail of the latch coming in contact with the projection of the cut-off arm, but this sound could hardly be termed disagreeable, and for that reason I think it is the other part of the latch where the objectionable noise occurs. The accompanying sketch will show what I intend to convey.

Scranton, Pa. CHAS. J. MASON.

Remedy for Noisy Valve Gear.

EDITOR THE PRACTICAL ENGINEER:

Replying to the request of A. C. Hornbeck, Tenn., as to the cause and remedy for noisy valve-gear, the writer will submit the following: I should judge that the noise is caused either by the body of the hook H striking the



Proper Position of Block

block B at A, or, if all of the clearance is at C, the hook would have some distance to travel before engaging the block, so that when the hook and block came together there would be considerable noise.

If the hook strikes the block at the top it may be due to any one, or a combination of, the following causes: The plunger may not seat properly in the dashpot, on account of too much cushion, or there may not be enough oil on valve, which would cause it to stick and prevent proper seating of plunger. If the packing was hard and dry, and was screwed up too tight around valve stem, it would have the same effect. If it is found that the plunger does not seat as it should, try some kerosene oil in the dashpot, as it may have become gummy from the oil used in it. Change the adjustment of screw S; examine the valve stem packing, and renew it, if necessary, and give the valve a little more oil. The clearance at C and A should be equal; if it is not, back off nut N and screw rod R in or out, as the case may require, until the clearance is alike on each side of the block. Would advise adjusting the clearance first which may be all that is necessary. If not, the above remedies may be tried.

Albany, N. Y. A. K. V.

Remedy for Stuffing-Box Trouble.

EDITOR THE PRACTICAL ENGINEER:

I wish to say to R. C. concerning his stuffing-box and gland trouble that I have found from experience that it does not pay to use a hard packing on pump rods or to allow rods to wear down too much. I have a Worthington 6"x4" x6" duplex feed pump which, when I took charge about five years ago, had two broken glands and one stud-bolt stripped; also rods badly worn on water end, caused by hard packing. After the pump was overhauled I commenced using a softer packing with a diagonal wedge, which, although costing more, is cheaper in the end. When rods show considerable wear I have them trued up as soon as possible and although pumping water at near 200 degrees and running 24 hours per day, I have had no trouble. I would suggest that R. C. take the opportunity to have the rods turned or new ones put in, also look after the cylinder lining, and then try a good wedge packing, and always keep the glands as loose as possible. Both sides should be adjusted evenly, as tightening one nut more than the other will cock the gland to one side and wear rod much faster than it otherwise would.

A good way to determine if the gland is properly set is to use a wedge of soft wood, and by trying both sides and noting how far the wedge enters between the gland and cylinder, a true adjustment can be made. This may seem like unnecessary work, but it pays in the end.

Trenton, N. J. H. H. Y.

If Engineers Were Owners, Then—.

EDITOR THE PRACTICAL ENGINEER:

In the January number, in reference to blow-off valves, E. S. H. writes: "To read the papers I would infer that all was well, but when I get around to the plants, I find that a great number are not right." Now this may be true, but E. S. H. should not always blame the engineer when things don't suit him, without getting the engineer's side of the question. In many cases, what should be done and what is done, will not depend on the engineer, but often upon what his employer thinks should be done. I know several employers who positively will not allow any changes unless it is absolutely impossible to operate without them.

As engineers, we all know it is good practice to have two cocks on the blow-off pipe, but it is another thing to convince some employers of this fact. They reason it out that as things have gone along for years O. K. with one valve, it will likely continue. Foolish reasoning, but the thing is to convince the other fellow.

E. S. H. also thinks that the engineer should give in a written report every month about the blow-off valve. Well, in all good plants, the engineer has to give in a written report about a whole lot of things, sometimes each day, but in many hundreds of small plants, the engineer in charge is the only man in the building who knows what a

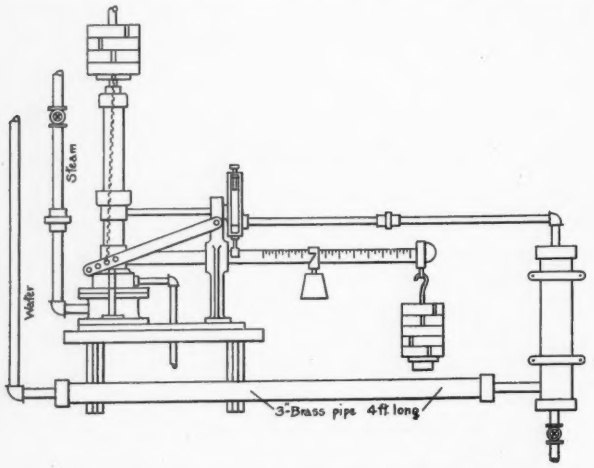
blow-down valve is, and even if he could get some one to read his report, the reader would not know what he was reading about.

Toronto, Can. E. L. T.

Arrangement For Giving Damper Regulator Clean Water

EDITOR THE PRACTICAL ENGINEER:

At one time I was working on a job where the water supply was a dam built across a mountain brook and every time it rained, the water became very dirty, so that we had to wash out the boilers every week, and sometimes oftener. The boilers did not seem to scale much, the deposit being mostly soft mud, but it was the damper regulator that gave the most



Arrangement for Giving Damper Regulator Clean Water

trouble. The valve would get stuck and, as the engineer could not run with hand damper, it made it very unpleasant, so I determined to get clean water to the damper-regulator. I got a 4-foot length of brass pipe, 3" diameter, and connected it up as shown. All the engineers who saw it said that it would not work, but it did, and my damper troubles ceased from that day. T. S.

Pittsfield, Mass.

Questions Asked Applicants for Second Class Licenses in Massachusetts.

EDITOR THE PRACTICAL ENGINEER:

To the fireman or young engineer who is studying for advancement, and who is looking for a higher license, it is often a great relief to know through what ordeal he will have to pass to get a license. To the man of good practical experience, it is only necessary to keep cool and to remember that the inspector is not there to bully, but to find out what the applicant knows. While there is no regular set of questions that the examiners use, the following list of questions, which were asked an applicant for a second-class engineer's license in Massachusetts, will give a good idea of their general scope:

1. What kinds of boilers are you most familiar with?
2. Do you understand a B. & W. boiler?
3. Where would you look for trouble in this type, especially as regards construction?
4. How is this boiler supported?
5. How many lugs have you seen on a tubular boiler?
6. How would you know that the blow-off pipe of the boiler was connected properly?
7. What precaution would you use in feeding boiler compound, and why?
8. How does a gravity heating system work?
9. Did you ever see a heating system without a check valve in the returns?
10. Could you run one that way?
11. How could you tell if the check valve on the feed line was leaking?
12. If you went into a boiler room where there was a single pump, you started it and it made a stroke and stopped; you started it again and the same thing happened, what, in your opinion, would be the matter?
13. If you took charge of a battery of boilers and you burned two and a half tons of coal a day, and if at the end of nine months you were burning three and a half tons, the boiler being clean and the same draft, etc., being used as at the beginning, how would you account for the increased fuel consumption?
14. What different kinds of joints are used in making a tubular boiler?
15. What is the percentage of strength of the different joints?
16. Is there any way that you could account for the engine using too much steam, besides leaky valves or piston? ton ?
17. If an engine cut off later on one side than it did on the other, what effect, if any, would it have on the fuel consumption?
18. How could you tell, without the aid of an indicator, if the valves of a Corliss engine were leaking?
19. Would you prefer that your steam valves should leak rather than the exhaust valves ?
20. What regulates or limits the cut-off in a Corliss engine?
21. Did you ever have charge of a condenser?
22. What automatic arrangements are there about a condenser ?
23. What is the cause of losing the vacuum?
24. If the vacuum was lost, would it do any damage?

Boston, Mass. T. O.

Will Open End Pump Plungers Work as Well as Solid End Plungers

EDITOR THE PRACTICAL ENGINEER:

I have in my charge a 10"x6"x12" Dean outside-packed plunger pump which was formerly fitted with standard solid-end hollow plungers, but, after a wreck, in which both outboard plungers were broken, it was fitted with open-end hollow plungers with walls about ¾" thick. The pump was put in fine shape, including a new water-end, new brass valves and seats, only the two inboard solid plungers being used. The pump takes cold water under an 8-foot head and works fairly well, although the hollow plungers make a slight jump at the beginning of the discharge stroke when pumping for the tube cleaners, but when cut in on the boiler-feed line and taking water at 210° under a 4-foot head, the pump does not give

satisfaction, and at best will only feed 5 boilers when it formerly fed 6 boilers with ease, the other conditions being the same.

My opinion is that it is on account of the open plungers, and if this pump were required to lift the water instead of getting it under a head, it would not pump any water with the outboard end, or very little, because an air-pocket would be formed in the plunger which would expand in the suction pipe and prevent a vacuum being formed.

This pump is giving us a lot of trouble, although it has been overhauled and examined by several engineers and machinists, some of which were expert pump men, and most of them agree with me, that the open-end plungers are at the bottom of the whole trouble, although I cannot get the master mechanic, who, by the way, is a technical man, to see it that way. He says, "Other things being equal, a plunger-pump will work as good and handle as much water with open-end plungers as with solid-end plungers," and although he may be right, I cannot see it that way, and would like to have the opinion of others about it.

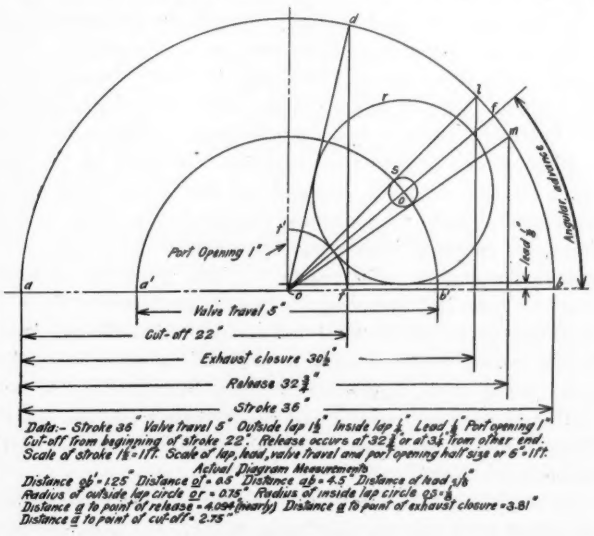
J .C. H.

Elyria, O.

Application of the Bilgram Valve Diagram.

EDITOR THE PRACTICAL ENGINEER:

The accompanying diagram illustrates the application of the Bilgram Valve Diagram to a given set of data, from which the reader can see just exactly how to proceed in any given case in which he has the valve dimensions, and from which he desires to learn the various parts in the distribution of the steam throughout the range of a stroke of the engine, to which the data belongs. The known data of an assumed engine is given from which, by its application to the Bilgram Diagram, the various events of the stroke are found. The diagram is to be drawn to the scales as


Port Opening 1"
Valve travel 5"
Cut-off 22"
Exhaust closure 30½"
Release 32¾"
Stroke 36"
Lead ¼"
Angular advance
Data:- Stroke 36" Valve travel 5" Outside lap 1½" Inside lap ¼" Lead ¼" Port opening 1"
Cut-off from beginning of stroke 22". Release occurs at 32¾ or at 3¼ from other end.
Scale of stroke 1½ = 1in. Scale of lap, lead, valve travel and port opening half size or 6 = 1in.
Actual Diagram Measurements
Distance o'o = 1.25" Distance o'r = 0.6" Distance o'b = 4.5" Distance of lead 1/16"
Radius of outside lap circle or = 0.75" Radius of inside lap circle os = ¼
Distance g to point of release = 4.094 (nearly) Distance g to point of exhaust closure = 3.81"
Distance g to point of cut-off = 2.75"

given, and the actual diagram measurements as drawn to the scale are given in the lower part of the diagram. In one case the dimensions are to the scale of 1½ inches equals one foot, which means that the distances as drawn on the actual diagram are to be multiplied by 8 in order to get the required figures that are given at the base of the diagram itself. In the other case the scale of the diagram is half-size or 6 inches equals 1 foot, and here the dimensions, as obtained on the diagram, are to be multiplied by 2, in order to get the required dimensions. As an example, the stroke of the engine is stated as 36 inches. In the diagram, before reproduction, it was drawn to the scale of 1½ inches equals one foot. The actual measurement of this line on the diagram was found to be 4½ inches; expressed decimally 4.5. Now then, by multiplying 4.5 by 8, as stated in the explanation, you will get 36 inches as a result, which is the figure stated. In the same way the other figures that are required to be found may be multiplied by 8, when the actual figures representing the dimensions are considered. In the same way for the other part of the diagram, which was drawn half size, you simply multiply the given distance by 2. For instance, the radius of the outside lap circle, *o r*, as measured on the diagram equals 0.75" or ¾ of an inch. This multiplied by 2, of course, will give 1½ inches, which is the outside lap of the valve in the engine.

A careful study of the diagram and this explanation that accompanies it should make clear to the reader just exactly how to use it with any given set of figures in any given engine. Drawing the figure itself is not at all a difficult operation, and requires no particular skill in the art of using drawing instruments. It is simply a matter of drawing a few circles, semicircles and straight lines, arranged and distanced as shown in the diagram.

Scranton, Pa. CHAS. J. MASON.

E + E. Education Plus Experience, the Necessity of the Times.

EDITOR THE PRACTICAL ENGINEER:

There has been quite a controversy lately among the readers of THE PRACTICAL ENGINEER in regard to the value of "experience *vs.* book-learning" in running a steam plant. Some twenty-five years ago, there was no more to steam engineering but that a man could easily learn it all in one plant, and then go ahead and tackle anything that was offered, and do it successfully, if he had any inclination towards things mechanical. To-day, we have arrived at a stage where neither theory or practice alone, but the two together are necessary to make a successful engineer. If "power engineering" continues to develop as it has done in the past few years, the stationary engineer will be a professional man in the true sense of the word, and the man without technical education will not be in it, except to fill minor positions.

As it stands to-day, there are plants of considerable size and paying good salaries, where all that is required of the chief is to keep things running, keep track of the bills, turn them into the office at the end of the month, and, if expenses are within reasonable bounds, everything is satisfactory. Such is a place for the practical man with experience. No theory is required, and hence the man who fills this position speaks of experience as being the most essential qualification.

There are other plants, probably no more complicated, and, no doubt, often run with no better showing on the balance sheet at the end of the year, where expense sheets are required every week, giving minute details as to oper-

ating expenses; where evaporation tests are made at regular intervals; where the heating value of the coal is found before it enters the furnace; where the CO_2 in the flue gases is obtained, etc. Here is where the practical man gets left, unless he has been burning the midnight oil in latter years and reading engineering journals, such as THE PRACTICAL ENGINEER, and it is doubtful if the college man is not already ahead in every instance.

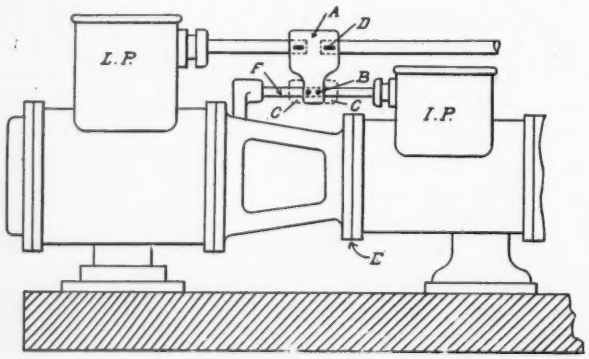
A man who takes charge of a plant of any consequence has his assistants to do the work. Of course, if he has had experience so as to know in detail how every little job should be properly done, so much the better; it will save him worry, and he will be more indepedent, but it is not absolutely necessary. On the other hand, the man who cannot give an intelligent account of himself, if called up to the office in regard to some contemplated change or addition to his plant, will find that his sphere of usefulness is getting more limited every year.

Chicago, Ill. R. C.

Use Reliable Sheet Packing For Gaskets.

EDITOR THE PRACTICAL ENGINEER:

I always have and still stoutly maintain that cheap machinery is a very poor commodity in the engine room, or anywhere else. A few years ago I was employed by a large pump manufacturing firm and on one job in particular I encountered two little features that proved not only detrimental to pump builders but very annoying to everyone concerned. I had just completed the installation of two triple tandem compound duplex direct-pressure pumping engines of three million gallons capacity each, and had started up one of them when the sheet rubber gasket on the outboard flange of the I. P. cylinder gave out as shown at



E. Of course it was necessary to take these two cylinders apart and put in a new gasket, which was no easy matter, and besides this gasket failure was the means of my having to put new gaskets throughout the two pumps because when I removed the gasket that had given out, it ran off the joint like jelly, proving it to be a poor imitation of some reliable sheet packing. This forever cured the manufacturer of using any but the best sheet packing. In summing up what it would have cost the company to have sent me back from the shop to put the new gasket in, I found that my car-fare, to and from the plant, summed up to $46.50 or more than enough to buy four sets of gaskets for one pump.

After we got the gasket in place and the exhaust piping connected, I put the pump in commission again and it had been running probably an hour when suddenly it stopped dead. I looked it over carefully, shut off the main throttle valve, opened up the cylinder drains and moved both sides with the priming valves, carefully watching each valve stem to see if any one of them had broken off anywhere, when I was suddenly rewarded by finding that the valve stem cross-head, A, had slipped on the valve stem, F. Upon examination, it was found that the two paper pins at B were sheared off in the stem. It was a very easy matter to take them out and replace them with new ones.

In order to make the connection good and substantial, which should have been done in the first place, I put on two steel collars, one on each side of the crosshead, each having two 5/8" case-hardened cap screws to hold them in place. The collars are shown by the dotted lines at C and C. I also put a split cotter in each of the keys as shown at D.

After the repair was made, the pump ran finely and the manufacturers could have saved considerable money if they had not built their pump on such a cheap scale.

Depew, N. Y. C. W. D.

Why the Engines Draw More Water From One of a Battery of Boilers

EDITOR THE PRACTICAL ENGINEER:

T. S., on pages 24 and 25 of the November issue, is certainly having an interesting time in holding down his new job, and I think his explanation of why the engines draw water from boiler No. 3, as shown in his illustration, is entirely correct. This boiler is so much nearer the main steam-pipe connection than any of the others, and the demand for steam is so much greater than the rate at which it can evaporate water at the low pressure of 80 pounds, that all the steam and water is drawn out before conditions can become equalized in the system. An illustration of this may be found in considering the priming action in boilers of the water tube type, not properly fitted with baffle plates, when suddenly called on for steam, or when forced beyond their capacity. In cases of this kind, where unusual demands are made on the boiler, as in making experimental tests to determine the proper location of baffle plates, for example, large quantities of water have been drawn over to the engine. The reason for this action is, of course, found in the small liberating surface in the drum of the boiler as compared to the demand for steam. Also the accelerated boiling caused by a reduction in pressure on a sudden call for steam being made, aggravates matters by agitating the water so that it is drawn over more easily than would be the case under normal conditions of regular evaporation and regular demand for steam.

This is exactly what takes place in the battery of boilers described by T. S., the fact being that, under ordinary conditions, boiler No. 3 furnishes more than its proportion of the total steam supply, assuming, of course, that all the stop valves are open equally. While the fires are burning well, and the steam pressure stays up as it should, the only effect of the increased work thrown on boiler No. 3 is to call for more careful and regular firing of this boiler, but as the fires burn slower and the steam pressure falls there comes a time when

the rate of evaporation in boiler No. 3 is not sufficiently rapid to furnish the extra amount of steam taken from this boiler. The first effect under these conditions is for the engines to draw on the reserve supply of steam stored in the steam space of this boiler, and for a few minutes just after this begins to occur, T. S., if he will watch his gauges carefully, will see that the pressure falls more rapidly in boiler No. 3 than in the other boilers. In a short time the stored steam in boiler No. 3 is used up and the lowering pressure gives rapid ebullition so that water in the form of spray is drawn over more readily than under other conditions, and boiler No. 3 is emptied before these different effects have had time to show themselves in the action of the other boilers. Thus it happens that the boilers which appear to behave the best are in reailty tardy laggards that fail to do their share of the work.

This action of unequal demand on boilers located at different distances from the connection to the steam main is well illustrated by considering the modern practise of refrigerating engineers in making connection from the main expansion valve in an ice plant to the various expansion coils of the freezing tank. Formerly it was thought sufficient to give simple pipe connections from the expansion valve to all of the coils, but this is no longer the case, as with such arrangement some of the coils were found to be doing comparatively little work, the greater part of the gas flowing through those coils nearest the expansion valve. If this is true with the free-flowing ammonia gas to such extent that it has now been found necessary to put regulating expansion valves on each of the coils, how much more it must be true in the case of the more sluggishly-flowing steam. If the demand for steam was equalized on all of the boilers the effect of a sudden increase in the demand, or of slower burning fires would be seen in a gradual and equal lowering of the pressure in all the boilers.

T. S. can probably stop priming on boiler No. 3 by partially closing the stop valve of the connection to this boiler. This will of course have a certain throttle effect, but it will not be necessary to close the valve enough to cause any appreciable loss on this account. Another method of remedying the difficulty is to use larger pipe connections to boilers 1, 2, 4 and 5 than the connection on boiler 3.

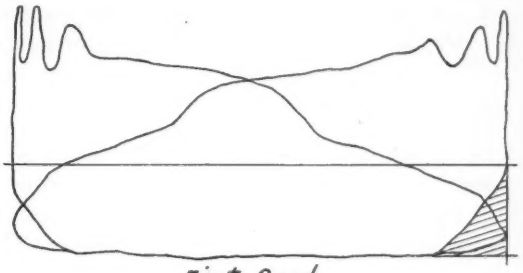
Rougemont, N. C. M. W. A.

Remedy for Pounding Engine.

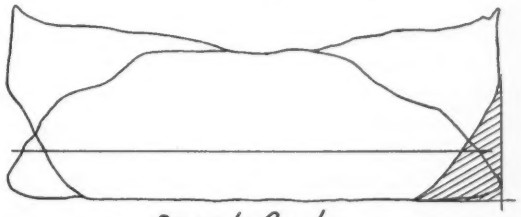
EDITOR THE PRACTICAL ENGINEER:

In reading the article in reference to the pound in the Fitchburg engine, I notice C. N. L. says that his engine is pounding to beat the band. In the first place, the engine is making a pretty good speed for this type of engine, and it will need a considerable compression, in order to stop or cushion the moving parts quietly. In the first card, which gives such a pound, the amount of compression, when run with 25 inches vacuum, is shown by the shaded lines. In the second card, the compression is much grater and the vacuum is less. Now when there is the greatest vacuum, there is less steam left in the exhaust end of the cylinder, and consequently with less compression it causes the engine to knock more. Now some engineers think that the condenser removes all the steam, but that this is not the case is shown by the compression on the first card.

To remedy the trouble, I should say it would be well to put pressure on the low pressure exhaust valves, and see if they are not leaking. This would lower the compression, with a high vacuum, and from the card it appears to me as if they are leaking some. It would be well to put steam in the low pressure cylinder and notice if the valves leak. Another point that is evident from the second card, is, that the admission valve should admit steam earlier than it does.



First Card



Second Card

If the engine knocks after it is found there are no leaks in the exhaust valves in the low-pressure cylinder with full vacuum, move the exhaust eccentric ahead, which will give an early closure and more compression. This should stop the knock, and by making the admission right it will help the engine. Lost motion in the valve gear should be looked for, and be removed.

Late admission will cause a knock the same as low compression, but in this case it may probably be caused by a combination of the two, remedying both of which should give a smooth running engine.

Lynchburg, Va. C. M. G.

The Harder an Engineer Works for His License the More He Will Appreciate It.

EDITOR THE PRACTICAL ENGINEER:

I notice that the Massachusetts license law is still a topic for discussion in your valuable paper, and I suppose it always will be as long as there are engineers looking for better licenses. Some engineers that have licenses seem to want to keep them all to themselves and make examinations so hard that only a few can pass it, and perhaps they couldn't pass to-day if they were examined. There are others that have failed and rather than work and study they cry down the license law and examiners. But there is a class, if they fail, that work harder and in the end they get their license and they deserve it.

The discussion of late has been whether the questions on the 2,000 horse power engine are fair ones or not. It has been my idea that any engineer, wishing a first-class, should be able to answer them. Of course, that would only be part of an examination and he would not be judged wholly from

them. An engineer should thoroughly understand the properties of steam, how to figure the horse power of an engine, understand indicator cards, be able to adjust valves to get best economy, etc.

In the questions asked on the compound engine there is nothing more than that, except the steam pressure, receiver pressure, etc., which he must assume. Most any engineer, if you should ask him, would have some idea as to what was the most economical boiler pressure, receiver pressure and vacuum and what type and speed of engine would give the best results, and especially so if he were operating a compound condensing engine, as a good many engineers looking for a first-class license operate that type.

It has been said that when designers differ, engineers should not be expected to judge. I thing that could apply to any appliance about a steam plant or in any other kind of machinery. In the construction of boilers, designers differ, but that does not hinder the engineer from determining the strength of the seams, etc., nor does it keep him from having his own ideas as to which is the best design, and his good judgment in that respect is what makes him valuable to his employer and perhaps swells his pay envelope.

An engineer who is interested in his own advancement would probably subscribe for one good engineering paper. THE PRACTICAL ENGINEER would fulfill all his wants. Almost every issue gives full accounts of new installations, the dimensions, pressures used, and the minutest details in regard to their construction and operation. It also gives tests on them, and from these the engineer can get an idea of which designs and pressures give most economical results. If some of the engineers, who are refused licenses, would go home and study the subjects on which they fail, instead of trying to argue the license law out of existence, they would get their license, if they kept at it.

An engineer asking for a license to take charge of any plant in the State of Massachusetts should know more than to just set valves and tell what to do if he had a hot bearing or some other similar occurrence. The harder a man works for his license the more he will appreciate it and the more it will be worth to him.

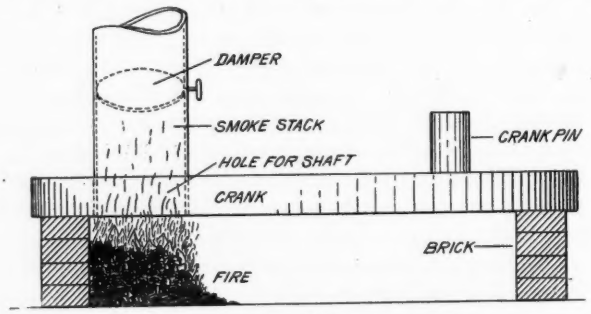
N. Abington, Mass. R. D.

A Crank Repair

EDITOR THE PRACTICAL ENGINEER:

Some time ago, a crank was broken on a 16"x36" Corliss engine, due, it was thought, to water in the cylinder. The approximate size of the end of shaft was telegraphed to the factory and a new crank ordered. Upon arrival it was found necessary to file the hole a little larger, as it was too small. The crank was then set upon bricks with the finished side up and a fire started under it. A couple of lengths of old stovepipe, containing a damper, was found and rigged up above the hole, which carried the smoke away, besides affording an excellent draft, which could be regulated by means of the damper. A gauge was made of heavy wire, about 1/32" larger than the diameter of the shaft, and the crank was heated until the gauge fit freely in the hole.

A guide-key was prepared, somewhat narrower than the keyway, in order to bring the keyways of the shaft and crank in line. Block and tackle were rigged up above the end of the crank-shaft and a chain fastened to the crank. The crank was then hoisted and slipped on and then braced to keep it tightly against the shoulder of the shaft while cooling. When cool, the guide-key was driven out and the permanent key fitted and driven in. Of course, the boxes were removed, as



Connections for Feed Water Regulator

the heat would have melted the babbitt. In case the boxes could not have removed, the shaft would have been moved over far enough to keep the heat from injuring the babbitt.

Burlington, Ia. G. E.

Old-Time Engineering.

EDITOR THE PRACTICAL ENGINEER:

A short time ago the writer, being on a visit to England, took occasion to visit the different steam plants where it was possible to gain admission, and while doing so he ran across a unique combination in a country flour mill. After meeting the engineer, he led the way through various subterranean passages until we reached that portion of the building that was reserved for the motive power, and here I found about the first engine that was ever made, and I guess they destroyed the model, for I never saw another one like it.

The engine had a 16-inch cylinder, with a 24-inch stroke, and was trying to make 45 revolutions per minute. The cylinder was below the floor, the cylinder being buried in the ground, with the shaft overhead. How the drips were disposed of I could not see, as there were no drip valves in evidence, except a small air-cock screwed into the top head. On the crank-shaft of this vertical engine was a balance-wheel about 7 feet in diameter. The shaft extended through the wall and was connected to a set of gears in conjunction with an over-shot water wheel. The engineer told me that the arrangement had given him considerable trouble to keep both the engine and water wheel "in gear," as he called it, but I think the trouble was that they were not speeded up so as to balance each other on the load.

While admiring these qualities, I noticed a lot of scrap-iron going around with the balance wheel, which, upon closer examination, proved to be old shaft couplings fastened by means of wires to the different spokes. This, the engineer informed me, was an improvement that had been made by himself, because when he took charge of the engine it had a bad "chuck" at each end of the stroke, and he put the weights on to swing it over the centre, which he said did not stop all the "chuck," but only helped it. By "chuck" he meant "pound," for it certainly was terrible. The way

I sized up the situation was that there was no lead on the valves, and the piston coming to the end of the stroke had no cushion, and when steam was admitted the crank had passed the centre on the return stroke. The idea of advancing the eccentric to get more lead and admit the steam on time never entered his head.

The pump feeding the boiler was connected to the main shaft and was worked by means of an eccentric on the shaft. The pump was compelled to run continuously when the engine was running, the regulation of the water being adjusted by means of a three-way cock. When the water was low in the boiler the cock was turned to feed the boiler, and when enough water had been obtained the three-way was turned to discharge back into the mill-stream.

The only modern device about the plant was a Pickering governor, which the engineer informed me was a recent acquisition. The governor was practically of no use, because the old engine could not get away very far, as any increase in speed would only tend to drag the water wheel more than it was already doing.

The boiler was of the old-fashioned internally-fired, 2-flue variety, and was situated outside the main building, the sides and ends of the boiler setting being open to the weather. It was impossible to tell how old the rig was, as there was no date in evidence, but it certainly was the most unique plant the writer ever had the pleasure of visiting.

Bridgeport, Conn. C. H. T.

Compound Engine Calculations.

EDITOR THE PRACTICAL ENGINEER:

In the January, 1908, issue, under the subject of "Dimensions for 2500 H. P. Compound Engines," I notice that B. A. L. attempts to correct R. T. in regard to the diameter of the high-pressure cylinder as obtained from its area. Either B. A. L. did not check his calculations carefully, or he does not understand the method of finding the diameter from the area, as he has not in any case found the diameter from the area, or the area from the diameter correctly. It is likely that the wrong method was used, and in this connection, the following may be of assistance. If A=area d = the diameter of the cylinder, then $A = .7854\, d^2$ and $d = \sqrt{A \div .7854}$.

There is a slight mistake in R. T.'s solution in finding the diameter from the area, but this is probably either a slip of the pen or a typographical error, as he has used the correct figures elsewhere in his solution. Taking the area of the high-pressure cylinder as 907.2 as found by R. T., the diameter becames $d = \sqrt{907.2 \div 7854} = 33.98$ inches or say 34 inches.

Dunmore, Pa. T. W. H.

EDITOR THE PRACTICAL ENGINEER:

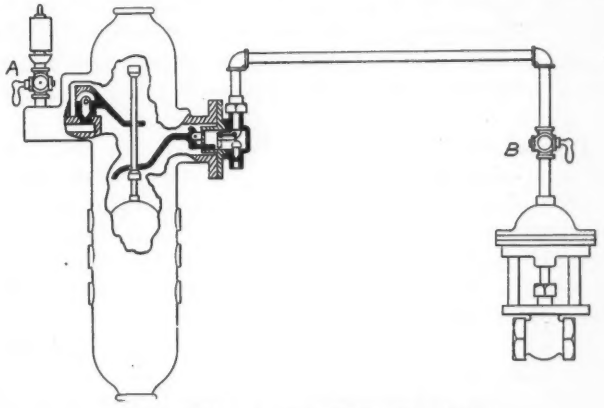
In the January issue, I notice the letter of B. A. L., in reference to my solution of the 2500 H. P. compound, condensing engine problem, in which he calls attention to what he considers an error in the calculations in my letter. I have gone over my figures and fail in any way to discover any error such as he speaks of. I repeat that 33.9 inches diameter will give an area of 907.2 square inches. Mr. B. A. L. figures 1094.94 square inches area, to realize the diameter of 33.9 inches, while according to the proper formula, $D = \sqrt{1094.94 \div .7854} = 37.3$ inches diameter. He evidently omitted to divide the area by .7854, simply taking the square root of the area to obtain the diameter. He also makes the same error later in his own calculations, when he states that 1056 square inches will give 32.49 inches diameter for high-pressure cylinder, and 2667.67 square inches area will give 51.5 inches diameter for low-pressure cylinder. The true values are 37 inches, nearly, and 58 inches respectively, making quite a difference in the results obtained. Such a mistake detracts considerable merit from the article, and it may be timely to point out that the constant .7854 must be used in all problems relating to finding the diameter and area of circles.

Germantown, Pa. R. T.

Connections for Feed-Water Regulators.

EDITOR THE PRACTICAL ENGINEER:

The accompanying illustration shows the method I used in connecting up the Williams safety feed-water regulator. By placing a valve between the whistle at A, and one between the controlling valve and column at B, any time I wish to cut out the automatic feed, I can do so by closing the two globe-valves and feed by hand-regulation. In places where engineers must bank their fires for the night, these globe-valves come in very convenient.



Connection for Feed Water Regulator

One morning I stopped in another factory while on my way to work and I noticed the engineer had a rag wrapped around the whistle of a Berry regulator. He said that he did this every night, because there was nobody in the place at night and he had to fill the boilers with water so that it would last until morning. If any engineer is troubled in this way, he can remedy it by placing the valves as shown. G. O. B.

South Bethlehem, Pa.

Working of Injector Under Low Pressure

EDITOR THE PRACTICAL ENGINEER:

Here is something that I think will be of interest to your readers. The other Sunday I was passing through our boiler-room and I noticed that the steam-gauge showed 20 pounds and no water could be seen in the glass. I called the fireman's attention to it, and as we did not have any feed pump, he went to the injector and in a short time the water showed 3 gauges. I never saw or heard of an injector working with 20 pounds of steam before. W. S.

Fall River, Mass.

QUESTIONS and ANSWERS

THE editor will be glad to receive from the readers of THE PRACTICAL ENGINEER, such questions relating to engineering subjects, as may, from time to time, occur to them. All questions and answers should be addressed to the editor and accompanied by the name and address of the writer, which will not be published, however, unless especially desired. It is the intention that questions shall be answered by the readers, and even though the editor may, from time to time, publish answers and questions, he especially desires the readers in such cases to contribute any further information, in connection with the points raised, that they may consider of interest. All questions and answers received by the editor will be published, as far as practicable, but he reserves the right of editing or rejecting any communication.

Testing Boilers. Connections for Pulsometers.

EDITOR THE PRACTICAL ENGINEER:

Could you or any of your readers kindly let me know through one of your numbers how I should proceed in a case like this: I am in a country place where I am called upon by the owner to erect a second-hand engine and boiler, and work the same. On examining the engine I found that certain repairs were necessary, which I did, but as regards the boiler, it seemed very old to me and I could get no particulars regarding the pressure at which it had been worked before. There were no boiler surveyors nearer than a thousand miles or more, and the owner would not go to the expense of bringing a surveyor that distance when I suggested it to him.

How should I proceed to test the boiler so that I will know at what steam pressure I could work it with safety? I have all the appliances for testing by hydraulic pressure, hammers, etc.

Will a pulsometer pump with openings for a 3¼-in. suction and 2 ½-in. delivery work when the suction pipe is 2¼ in. and delivery pipe 1½ in. diameter?

C. A. M.

Calcutta, Ind.

The testing and inspection of a boiler involves a knowledge of the causes which tend to wear out a boiler and the proper judgment in deciding how far the various causes of disintegration have interfered with the strength of the boiler. A person making a boiler inspection should have a knowledge of the construction of the boiler, its proper setting, the proper appliances used on the boiler, etc., and he should be well versed with respect to the effects of corrosion and overheating, the proper method of staying and bracing, and the proper method of making connections for the satisfactory relief of excess pressure, means of cleaning and means for insuring a proper water level.

Assuming that the boiler has met satisfactorily its inspection as regards to physical appearance, the inspector should then satisfy himself that the boiler is able to withstand its working pressure by putting the boiler under a pressure somewhat higher than that which it is expected to carry, and observing whether under such pressure the boiler shows any signs of weakness, deformation or leakage. It is usual to expose the boiler to a pressure test of at least one and one-half times its working pressure.

For making the examination of the condition of the boiler, much reliance is generally placed by treating all parts of the boiler with blows from a light hammer. The blow upon a loose rivet or faulty stay will generally be revealed by the sound. The hammer will also indicate and reveal defects in the shell such as cracks, blisters and laminations. When a plate has begun to laminate, the hammer-blow will immediately indicate that the plate is no longer solid at that spot.

When making the pressure test, the boiler is filled with water and by means of a pressure pump, the pressure is raised to about one and a half times the usual boiler pressure. While the boiler is subjected to this internal pressure, it should be carefully examined for bulging and for leakage. Should any defect be shown before the desired pressure is attained, then the hydrostatic pressure should be reduced until the boiler does not leak or does not show any sign of weakness. The safe steam pressure should be about one-half the amount of hydrostatic pressure which the boiler is capable of standing. Opinions may differ as to just what that pressure should be, but since safety is the first consideration it is better to err on the right side.

While a pulsometer may operate with steam and discharge pipes smaller than those called for by the pulsometer, it is advisable not to operate them under those conditions, because the loss of head due to the excessive friction of the smaller pipes may reduce the capacity and may probably break the continuity of flow when operating under severe conditions. The manufacturers of pulsometers give positive instructions that no smaller pipes should be used, and if a pipe of considerable length is necessary, a size or two larger pipe should be used, bushed to the proper size at the pump, to allow for the increased friction. Bends, elbows, valves, etc., should also be avoided where possible, as all pipes should lead direct to the pulsometer if possible.

Pulsation of Boiler. Centrifugal Force. Boiling Point.

EDITOR THE PRACTICAL ENGINEER:

I would like very much if you would answer the following questions in your paper, if it isn't asking too much of you:

1. What causes a horizontal return tubular boiler to pulsate in its setting, and at what time is such action apt to be discernable?

2. What is a dry pipe in connection with a steam boiler, and what is its mechanical purpose?

3. In what way are centrifugal and centripetal forces obtained?

4. Where should the lower gauge cock be placed in upright boilers?

5. Explain why the pressure on the surface of the water affects the boiling point.

T. C.

Montgomery, Ind.

1. The pulsation of a boiler is generally caused by the rapid ebullition of the water in it, and the intermittent demands for steam which is made upon it. It is generally more noticeable when the boiler is being forced.

2. A dry pipe is attached to the interior of a boiler for the purpose of getting dry steam from the boiler. It generally consists of a pipe with closed ends, located inside of the boiler in the steam space, close to the upper side of the shell. The upper surface of the pipe is drilled or slotted with holes, and the whole arrangement acts similar to a separator.

3. Any body revolving around a fixed centre in any curved path exerts a force called centrifugal force, which is proportional to the weight of the body and the square of its velocity. If F = centrifugal force, W = weight of body, V = velocity in feet per second, g = force of gravity = 32.16 feet per second, and R = radius of circular path, then

$$F = \frac{W V^2}{g R}$$

The centripetal force is the same force of the same intensity as a centrifugal force, but its direction is always the reverse of a centrifugal force, the latter being a force which always acts from a centre, and the former being a force which always acts toward a centre.

4. As gauge cocks are used for the purpose of ascertaining the water level in a boiler, the lower one should be placed several inches above the lowest permissible water level. The exact location varies with different types of vertical boilers. In a Manning boiler, for instance, the lower gauge cock would be located about two-thirds of the distance between the fire-box and smoke-box.

5. The ease with which a liquid vaporizes depends upon the pressure which is exerted on the surface of the liquid; the greater the pressure, the more heat or energy is necessary to change it from a liquid to a gaseous form. This is a natural law and applies to water as well as any other liquid, so that the boiling point changes with every change of pressure.

Compound and Simple Engines. Surface, Jet and Siphon Condensers.

EDITOR THE PRACTICAL ENGINEER:

Will you kindly answer the following questions? They are some which have recently been given to applicants for Massachusetts first-class engineer licenses:

1. Which is the most economical, a compound or simple engine, and why ?

2. Which is the most economical, a single or duplex pump?

3. From what does the steam valve in a Cameron pump get its motion?

4. Describe the working of a siphon condenser.

5. Which is considered the most practical for stationary steam plants, the syphon, jet or surface condenser?

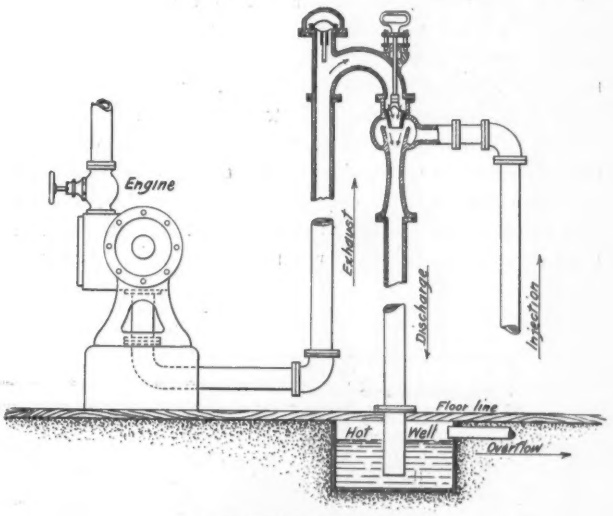
N. Abington, Mass. R. W. P.

1. The compound engine is more economical than the simple engine, because with the use of two cylinders a greater range of expansion can be obtained than with one, thus making each pound of steam do more work. If, however, the same range of expansion were permissible in each type of engine, the compound engine would have the advantage because the range of temperature between the initial and exhaust pressure in each cylinder is less than if the expansion were in the one cylinder only. The result of this is that there is less cylinder condensation in a compound engine. The effect of clearance in the high pressure cylinder does not affect the economy of the engine so much because this steam is used expansively in the low-pressure cylinder, and should there be any leakage in the high-pressure cylinder, the energy is not lost, but is utilized in the next cylinder.

2. The economy of a single and duplex pump is practically the same.

3. The steam valve in a Cameron pump receives its motion from two reversing valves which are placed in the steam and water end of the cylinder. The steam piston, when it advances to the end of its stroke, strikes one of these reversing valves which admits a small amount of steam to a plunger which shifts the slide valve and admits and exhausts the steam at the proper time, the reverse valve closing as the piston moves in the opposite direction.

4. The siphon condenser depends upon the principle that the atmosphere will not support a column of water over 34 feet high. It is, therefore, only necessary to arrange a condenser at that height above the hot well whereby the condensation of the exhaust steam will always cause a vacuum to be maintained above the water column in the discharge leg of the condenser. The siphon condenser itself consists of two cone-shaped nozzles which meet at the narrow ends. Within the upper cone, as shown, there is an inner cone around which the injection water flows, and through which the exhaust steam travels. When the exhaust steam from the engine meets the thin film of water it is condensed, and as the water flows down through the narrow neck of the condenser it carries with it the condensed steam and most of the air and vapor, leaving a good vacuum



The Siphon Condenser

above it. As the water expands and its velocity is decreased below the narrow neck, the air and vapor are prevented from filling the vacuum by the high velocity of the water passing through the neck of the condenser. Formerly no air-pump was used with this apparatus, but for high vacuums it is advisable to connect a dry air-pump to the top of the condenser. It is not necessary to use a dry vacuum air-pump, and it is not necessary to use an injection pump if the water flows to the injector by gravity. Under small heads it will also work without the use of an injection pump after the condenser is once started.

5. The question depends almost entirely upon conditions. If jet condensers are used, it is probable that it will not require so much condensing water as the surface, as the cooling water acts directly upon the steam. If the condensed steam is pumped back into the boilers, the injec-

tion water must not be impure or objectionable to the boilers. The surface condenser takes up more room than the jet condenser, and is more costly, but condensing water of any quality can be used. Generally speaking, it will give a better vacuum than a jet condenser, and the exhaust steam can be used over and over again in the boiler with the addition of only a small amount of make-up water. The syphon condenser is practically an injector condenser, and where head room and water supply are abundant they make a very economical and satisfactory installation.

Setting Valves on Fitchburg Engine

EDITOR THE PRACTICAL ENGINEER:

I have had considerable trouble with the valves of my Fitchburg engine. It is a 16 x 32, running at 108 revolutions per minute. Will you kindly explain to me how the valves are set? M. G. B.

Boston, Mass.

The Fitchburg engine has a valve gear of the four-valve type, as shown in Fig. 1. The valve gear is positive, with independent steam and exhaust valves. The upper valves are worked by means of a cam wrist plate, which gives a quick opening and sharp closure of the ports and controls the points of admission and cut-off, the latter being automatically varied by the governor. The lower valves control the points of exhaust, release and closure. The steam valves are of the double ported piston pattern, shown in Fig. 2. They have their rod attached to two cams, which are free to reciprocate in guides. Motion is imparted to the valves through the bell-cranks, B B, by the eccentric controlled by the governor. The exhaust valves are controlled by a fixed eccentric which operate the valve stem A. All valves take steam by their upper ends. The travel of the exhaust valves can first be evened up, before their eccentric is tightened upon shaft, by rolling the eccentric around shaft to its extreme throw at each end. It should then be set so that the port is just closed when the cross-head has traveled a little less than 7-8 of its stroke, and set screw firmly screwed upon the shaft.

To adjust the steam valves place the latch of the hook in the center of the half-spiral slot and clamp the hook firmly by its lever, evening up the movement of the wrist cranks by the right and left nut in valve rod, so that in a revolution of the engine shaft they rock evenly each side of a vertical line drawn from centers of their shafts; set engine exactly on the dead center and move the small valve rod attached to the head valve in or out of its cam until the port is opened the proper

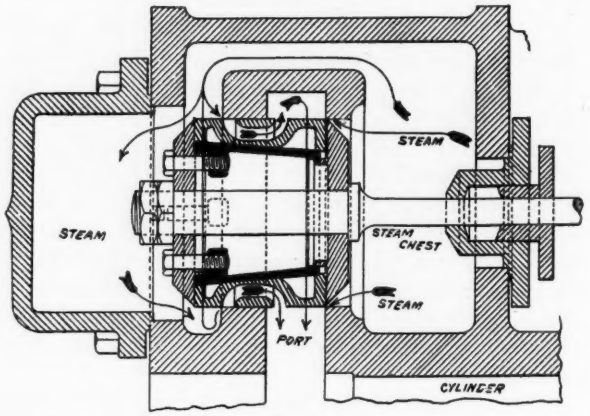


Fig. 2

lead, in usual cases about 1-16 of an inch, and tighten set screw in neck of cam upon the rod firmly. Roll engine to the opposite center and set the other valve in the same way. After the valves are thus set as closely as possible they should, if practicable, be adjusted by use of the indicator when engine is under partial or full load, as no mere measurements can ever set valves exactly right in any engine. In case a compound engine has an eccentric to drive the steam valves of the low pressure cylinder this will be turned upon the shaft till its offset is upon same side of shaft as is the crank pin, and until when the engine is on dead center and the eccentric is slipped in and out along the feather in its hub there is no movement of valve rod, as explained in setting the governor on shaft. The valves can then be set to give proper lead. The exhaust valves of low pressure cylinder can be set same as for high pressure cylinder.

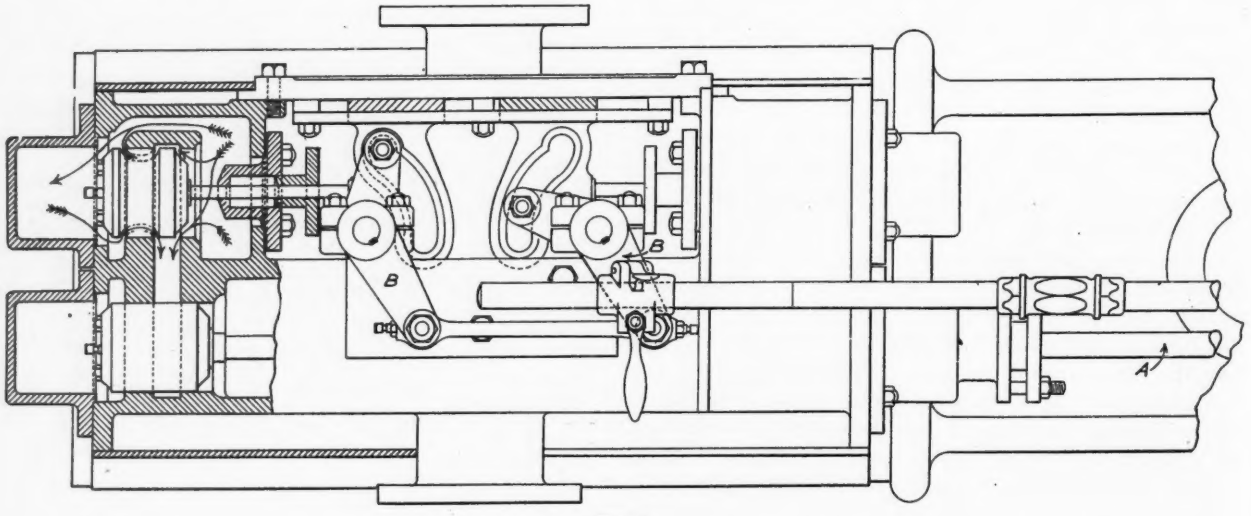


Fig. 1

The outer shell or surface of the valve is adjusted to its seat by moving endways the cone inside it; two tap bolts draw the cone back to loosen, two set screws force it forward to tighten. When valves are adjusted correctly to move easily by hand without looseness, see that bolts and set screws are left tightened firmly against each other, thus forming a lock against loosening. The cut will explain this clearly. In the larger valves there are four through bolts passing from end to end of valve to draw heads firmly upon the outside ring, these having two nuts each at outer end. In adjusting the valve the two tap bolts bearing upon head must be loosened up, then the nuts upon the four through bolts loosened a *very little,* perhaps 1-16 of a turn only and each one the same, and the two set screws screwed down. If not enough expansion repeat the operation until valves are just right. Then screw home the tap bolts and tighten securely the nuts upon the through bolts. In the smaller engines the valve heads are drawn down by the collar nuts upon rod, and these can be loosened very slightly in place of the through bolts. A little experience will make this easy, and it should be done in six or eight months after the engine is first started, after which every twelve months will be enough.

—o—

Increase in Pressure when Running Non-Condensing.

EDITOR THE PRACTICAL ENGINEER:

I would like to have your opinion on this problem: I am running an automatic cut-off engine with a good working load, the boiler pressure being 100 pounds, and the vacuum 26 inches. I am going to take the condenser off and use the exhaust steam for heating purposes, with 5-pound pressure of the building. How much will I have to raise the boiler pressure to enable it to do the same work without the condenser, as was done with it?

Medford, Mass. W. E. C.

Since a vacuum of 26 inches is equivalent to about 13 pounds, there will be a difference of about 113 pounds between the initial and back pressure line of the engine card when it is run condensing. In order to maintain the same cut-off and still obtain the same power from the engine, the difference between the initial pressure and back pressure, when the engine is run non-condensing, must be 113 pounds, and since the back pressure is 5 pounds above the atmosphere, the initial pressure must be at least 118 pounds. This is assuming that there are no losses in pressure in the engine cylinder or exhaust pipes. Practically, this is impossible, so that a pressure of about 125 pounds on the boiler should give the desired results.

—o—

Charging Gravity Batteries.

EDITOR THE PRACTICAL ENGINEER:

I have some gravity batteries and do not know how to charge them. Will you please tell me how to charge them, and give me other useful information? F. R.

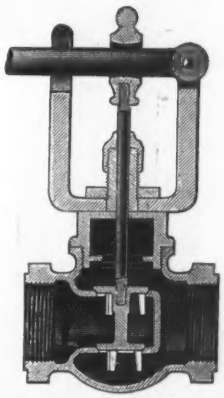
South River, N. J.

When charging a gravity battery, the copper sulphate, or blue crystals, as it is often called, is placed in the jar, and sufficient water poured on them to bring the level about the upper surface of the zinc. The crystals should be small enough to go through an 1¼-inch mesh sieve and large enough to go through a ¼-inch sieve. About 4 pounds of the copper crystals are placed in the bottom of the jar surrounding the copper element, and after the water has been added so that zinc element is covered, the battery should be short-circuited for at least 24 hours. This short-circuiting sets the cell into action and zinc sulphate is formed. This zinc sulphate solution gathers around the zinc element and forms about the upper one-third of the electroylte. The lower two-thirds of the electroylte is composed of copper sulphate solution; which is indicated by a deep blue color. If the cell is in good condition, a distinct line separates the copper sulphate solution from the colorless zinc sulphate solution above. If this upper solution was not protected from the atmosphere, the liquid would evaporate and white crystals of zinc sulphate would form on the jar, causing the liquid to become thick and reducing the efficiency of the cell. To prevent this, a layer of oil about ⅛ inch deep is placed on the top of the liquid, when it is ready for long use. Its electro-motive force should be about one volt.

—o—

The Nason Quick Opening Valve.

The latest and perfected type of the Nason "quick opening" valve is shown in the accompanying illustration, more than ordinary care being used in the manufacture of these valves, so that the parts are evenly balanced and but little force is necessary to open and close them, irrespective of the steam-pressure imposed upon them. They are constructed with a balanced valve with bevel disc seats, differing slightly in diameter, which permits the passage of the lower disc through the upper opening. Compensation for the difference in areas is provided for by a lever to which a suitable weight may be attached. The yoke has a swivel action, which enables it to be placed in alignment with any device to which it may be attached.



The Nason Quick Opening Valve

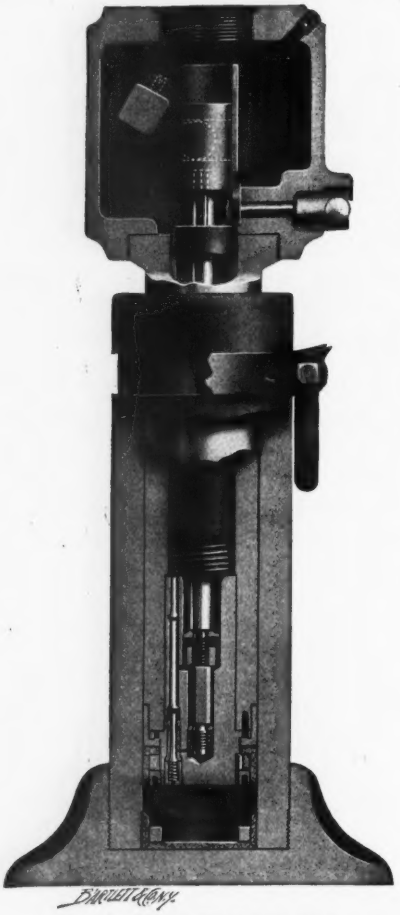
One of the many purposes for which this valve is used is the automatic controlling of pumping engines in elevator and tank systems. Connected in the line of steam supply to the pump to be regulated, the valves are operated by a float placed in the tank; the variation in the water level opening and closing the valve and starting and stopping the pump, as required.

These valves are also extensively used in connection with temperature-controlling devices, water motors, etc., or for any service where sensitive and positive action is required. The valves are made of steam-metal composition, but in larger sizes they are furnished with iron bodies and composition mountings if desired. The Nason Manufacuring Company, 71 Fulton Street, New York City, are the manufacturers.

The Universal Hydraulic Jack.

A very useful piece of apparatus around a power plant for various purposes is the hydraulic jack. In order for it to meet the average requirements, however, it should be light in weight, easily handled, operated and controlled, and should be efficient and reliable. A new type of hydraulic jack which combines these features is the Universal Hydraulic Jack, and has been designed as the result of many years' experience.

This jack has double pumps, so that if the load is light, or if the ram must be extended some distance before the strain commences, the two pumps can be used together until the strain becomes excessive, when one pump is thrown out by the turn of the handle. Reversing the handle throws both pumps into service again. The jack can be operated either vertically or horizontally and with the lever working at any angle.



The Universal Hydraulic Jack

The operation of the jack is shown in the accompanying sectional view of a double-pump jack. One pressure valve and two suction valves are used. With both pumps in action, a jack of 30 tons maximum capacity will lift a load of 15 tons at the rate of one inch in every six strokes. With only the lower pump working, 30 tons may be raised one inch with twelve strokes. The pumps are controlled by a valve handle that may also be used for lowering the jack, although the jack may be lowered in the usual way by the operating lever when reversed in its socket. When the valve handle is in the position shown in sketch, the cam at the end of its shaft allows the push tube to be held up by the coiled spring at its lower end, so that all the valves are free to seat.

The single pump action is obtained when the valve handle is turned down to a vertical position, which movement revolves the cam sufficiently to unseat the upper valve, so that the upper piston ceases to work. With this condition only the two lower valves are used, the middle one being the suction valve for the lower piston.

Turning the valve handle in the opposite horizontal position unseats all of the valves, allowing the ram to descend by its own weight. To lower the jack by means of the operating lever, the arm is depressed until a pin projecting from the lower side of the piston head encounters the top of the push-tube. The push-tube is used to throw out the auxiliary pump and to force the valves from their seats in order to lower or clear the valve seats.

The pump of this jack may be adjusted so that the ram may be extended horizontally as well as vertically. The interior parts are accessible, the valves being reached by removing the ram and unscrewing the bonnet. The piston packings are reached by unscrewing a plate in the head and lifting the piston through the opening.

The jack is operated in the usual manner, except in regards to the valve handle. When both pumps are used, the valve handle is turned to the left; when one pump only is required, it is turned straight downward. The jack is lowered by turning the valve handle to the right or by using the lever in the ordinary manner. Richard Dudgeon, 24 Columbia street, New York City, is the manufacturer.

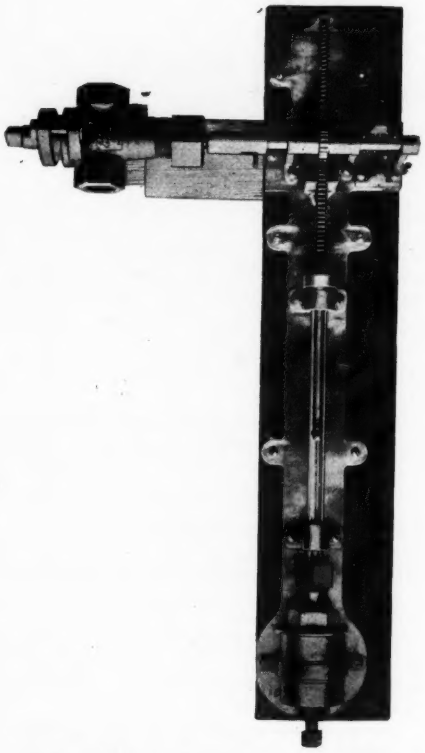
The "Economic" Automatic Refrigerating Valve.

In connection with refrigerating plants, especially those of small size, it is often desirable to install an apparatus which will control the temperature of the cold room automatically. This is quite important in connection with the number of small refrigerating plants which are now being installed and which are run continuously without practically any attention. The temperature of the cold room may vary so rapidly with the different conditions that constant attention would otherwise be necessary to maintain uniform conditions. The accompanying illustration shows an automatic refrigerating valve, used for this purpose, which regulates the supply of ammonia to the cold room, and which also regulates the speed of the compressor if desirable.

The automatic device used for regulating the temperature is placed in the cold room, and its action depends upon the expansion and contraction of the mercury which is placed in a closed receptacle, shown at the bottom. The mercury is allowed to rise in the column and presses against a piston which works a rack up and down as the mercury rises and falls. Engaged with the rack is a pinion on which the valve stem of the expansion valve is attached, which opens and closes as the rack rises and falls. On the opposite end of the pinion shaft the arrangement for regulating the ammonia compressor is placed. If the compressor is electric-driven, a commutator or make-and-break device is used, which regulates the speed of the motor, but when a steam compressor is used the pinion shaft operates the throttle valve supplying steam to the engine cylinder.

The action of the regulating valve is as follows: Should the

temperature in the cold room rise above normal, the mercury column expands, which moves the rack and turns the pinion. When the pinion turns, it opens the expansion valve and allows more ammonia to enter the refrigerating coils, and at the same time it opens the valve or turns the switch which regulates the speed of the compressor. As the temperature falls,



The "Economic" Automatic Refrigerating Valve

the mercury column contracts, the rack follows, the expansion partially closes and the compressor slows down.

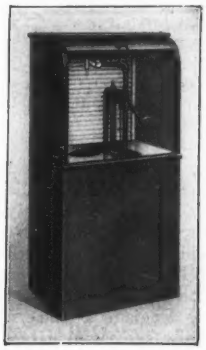
The normal temperature of the cold room may be regulated by means of a screw placed in the bottom of the mercury cup. By raising and lowering this screw the normal level of the mercury column is varied, which, in turn, regulates the degree of opening of the expansion valve or speed of the compressor. The Economic Refrigerating Company, 848 Drexel Building, Philadelphia, Pa., are the manufacturers.

The Bowser Oil Cabinet

In the use of lubricating oils around an engine room, it is just as important to properly store and protect the oil from dirt as it is to use it properly in the cylinder or upon the bearings of the engine. Much of the economy practiced at the engine may be lost if the oil is allowed to become dirty or be wasted in transferring it from the barrel to the oil-cans.

The Bowser Adjustable Measure Oil Cabinet is of particular interest to engineers, because it is especially designed to store lubricating oils in a safe, cleanly, economical and convenient manner. With this type of cabinet, the engineer can know that every drop of oil used will be just as pure and clean as when it left the refinery. Every drop of oil that is put into the cabinet may be used, as none of it will be lost through evaporation, seepage or contamination. The engine room can be as free from oily floor and walls and unsightly waste, as though no oil were handled there, and the engineer need never be troubled with oily hands or clothing; at the same time he can have the oil close by the engine at all times.

The latest model of Bowser Adjustable Measure Oil Cabinet is shown in the accompanying illustration. It is known as the All Metal Roll Top Cabinet, and is designed to meet the demands for an absolutely fireproof method for storing oil in the engine room. The cabinet is constructed entirely of heavy



The Bowser Adjustable Measure Oil Cabinet

galvanized sheet steel, riveted and soldered and finished in a dark maroon. It is fitted with a roll top, operating on the principle of a roll-top desk, which extends up and completely encloses the pump, so that no dirt, dust or grit can come into contact with the oil.

This cabinet is fitted with an adjustable measure oil pump, which measures accurate quarts, pints or half pints at a stroke. It is easily adjusted so that at one stroke it will exactly fill any oil can in use without waste, overflow or pouring back. Once the oil is placed in the tank it stays there, safe from evaporation and contamination until it is drawn into the oil-can. And, as only the exact amount desired is drawn, and that forced directly into the can, it does away with oily waste and the bother of soiled hands and clothing.

The manufacturers of this cabinet are S. F. Bowser & Co., of Fort Wayne, Indiana.

Steam Turbines Wrecked.

Through the explosion of a turbine generator in the power-house of the Los Angeles Gas and Electric Company, considerable costly machinery was wrecked and the engineer, L. Olsen, was slightly injured. The explosion is believed to have been due to a defective governor, but from whatever cause, one of the pair of turbines was blown into bits by the terrific explosion, the noise of which was heard for blocks. A piece of iron was hurled fifty feet across an open space to the other turbine and went through the casing of that turbine like paper. This wrecked the second turbine, a piece of iron from which was sent flying through the roof only to fall back upon a battery of pumps, completely wrecking them and causing a shut down of the plant.

The plant is also equipped with large Corliss engines, which were not damaged, and these are furnishing the light and power in the place of the wrecked turbines.

TRADE NOTES

EDITED BY THE ADVERTISING MANAGER

The Peerless Rubber Mfg. Company have recently opened their new retail department at 88 Chambers Street, New York, which connects with their present store at 16 Warren Street.

Owing to their somewhat limited space they have not been able to carry a large stock, but with the additional store, they will always have on hand a full and complete line of mechanical rubber goods to fill immediate demands.

Mr. Fred. G. Rollins, vice-president and Eastern manager for the Holmes Metallic Packing Company, is now located permanently at No. 15 Locust Street, Springfield, Mass., from which point he will be in close touch with the many users of Holmes Packings in New England. Mr. Rollins is well known and popular among New England engineers. He has also been deservedly successful. Users of Holmes Packing in New England will save time by communicating with Mr. Rollins at his Springfield address.

As force feed lubrication comes into more general practice its beneficent results are better understood and appreciated by engineers. In fact there are a number of important power-plants in which the Sterling Force Feed Lubricators have entirely displaced all other methods and in which elaborate and expensive oiling systems have been discarded for the more satisfactory force feed method. Sterling Force Feed Lubricators are fully described in a catalogue issued by The Sterling Lubricator Company, Rochester, N. Y.

"Where Water and Fuel are Scarce or Dear" is the title of a circular treating of the heating and purifying of boiler feed water in mining and smelting plants. The pamphlet is published by the Harrison Safety Boiler Works, 3144 N. Seventeenth Street, Philadelphia, Pa., and shows that by means of a Cochrane Heater, about 6½ pounds of water may be heated from 60 to 210° F. by one pound of exhaust steam, and further that the one pound of steam will be condensed and added to the boiler feed as pure distilled water, thereby saving 16 per cent. of the coal bill, as well as a nearly equal proportion of the raw water. Further heating the water throws out of solution the bicarbonates of lime and magnesia, which, along with mud, sand and other impurities, are precipitated in the heater instead of being carried over into the boiler. It is pointed out that as the heater does part of the work of the boilers, six boilers and a Cochrane Heater can make more steam, while requiring less fuel, less labor and less water, than seven without one.

The Foos Gas Engine Company, of Springfield, Ohio, have purchased the business of the Marinette Gas Engine Company, which comprises the line of Walrath multiple cylinder engines for electric and power work, from 20 to 500 H. P.

The Cherry Chemical Company, manufacturers of the Red Seal Boiler Compound, formerly at No. 10 N. Nineteenth Street, has removed to a larger building, No. 1018 Callowhill Street, where, with increased facilities, they are prepared to supply their many customers more promptly than heretofore. The use of Red Seal Boiler Compound has grown this past year beyond the expectation of the company, and they found it absolutely necessary to make a change.

Mr. Oliver Braden, who has been manager for the past fourteen years, is still at its head. This alone is a guarantee that your wants will receive prompt attention.

The confidence of its readers is THE PRACTICAL ENGINEER's most valuable possession.

Did you get one of those very clever folding lunch boxes which the Keystone Lubricating Company are giving away? If not you should make applicaton at once before the supply is exhausted. When empty this lunch box can be folded up and carried in the pocket. See ad. on another page of this issue.

The Liberty Compound Company, 136 Liberty Street, New York, has been incorporated by Mr. Harry N. Bennett and James O. Westburg, for the manufacture of boiler compounds.

The Sidelug and Nason Steam Traps, together with a large and useful line of specialties for the power-plant, are shown in the catalogue of the Nason Mfg. Company, 71 Fulton Street, New York.

The economy and safety due to automatic regulation of the admission of feed water to the boiler has been threshed out in theory and demonstrated in practice so often that most engineers have come to know that some sort of automatic regulator is an absolute economical necessity if the best results are to be gotten out of the boilers. The Safety Equipment Company, Fisher Building, Chicago, have issued a booklet describing the Gould Safety Feed Water Regulator, a copy of which they will mail to any engineer upon request.

The Perfection Grate Company, Springfield, Mass., announce that Mr. F. W. Ridlon, former manager of Perfection Grate Company, in order to look after his various other interests, has given up all active connection with the business of that company. Mr. Ridlon is succeeded by Mr. C. B. Campbell, who is thoroughly familiar with the requirements of the grate business.

Murray Corliss Engines are shown in an interesting and unique manner in their Series D, No. 7, pamphlet. The illustrations are most unusual and very complete, showing not only full external views of their various engines, but also sectional views in which each part of the engine down to the smallest detail is given its proper name. It represents a most extraordinary bit of work deserving of the highest commendation. We are sure that engineers generally will appreciate having a copy of this pamphlet, which may be obtained gratis by writing Murray Iron Works Company, Burlington, Iowa.

Adam Cook's Sons, 313 West Street, New York, manufacturers of Albany Grease, offer to send to any engineer or steam user, for trial, an Albany Grease Cup and a sample can of Albany Grease free. When writing give diameter of oil hole, depth of oil hole from top of cap to journal, where to be used, and firm's name; also mention THE PRACTICAL ENGINEER.

The Hartford Engine Works, of Hartford, Conn., recently completed an interesting job, consisting of the overhauling and putting in condition of a Woodruff & Beach engine, which was built in 1865. The engine is now in service at the factory of R. Rerschmann & Sons, 362-372 Second Avenue, New York. It is now in excellent condition and looks good for many years to come.

Kingsford Centrifugal Pumps and Pumping Machinery are shown in a handsome new catalog just received from the Kingsford Foundry & Machine Works, Oswego, N. Y. Engineers often fail to appreciate the advantages of centrifugal pumps. This catalog shows many illustrations and contains a deal of useful information and helpful data. A copy will be sent to any reader of THE PRACTICAL ENGINEER.

GAS ENGINEER would like position. Ten years' experience on Westinghouse and Allis-Chalmers gas and steam engines. Past two years on gas exclusively. First-class references furnished. Age, 35. Box 11, care of THE PRACTICAL ENGINEER.

WANTED—Engineers, Firemen, Electricians, Machinists, etc. New 25-page pamphlet containing questions asked by Examining Boards sent free upon request. Address, GEO. A. ZELLER BOOK CO., 4467 W. Belle Place, St. Louis, Mo. Established 1870.

Wanted Salesmen traveling among engineers to sell the France Metallic and Fibrous Packings. Good inducements on unoccupied territory, Address
FRANCE PACKING Co., Tacony, Phila., Pa.

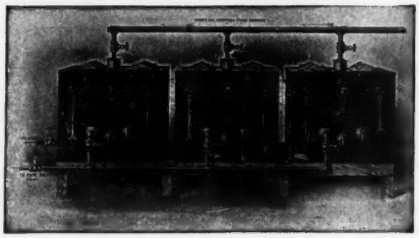
WANTED.—Engineers and Mechanics to make big money selling Incomparable O. K. Hand Soap. A 10-cent can will instantly remove more dirt and stains from the hands than four cakes of any soap made, and it will not injure the most delicate skin. Small sample free. *O. K. Hand Soap Co.*, 225 Congress Street, Boston, Mass.

PATENTS WATSON E. COLEMAN
Patent Attorney, Washington, D. C.
Advice and books free. Highest references. Best services.

PATENTS
C. L. PARKER
Late Examiner, U. S. Patent Office.
Attorney-at-Law and Solicitor of Patents.
Patents secured promptly and with special regard to the legal protection of the invention.
Handbook for inventors sent upon request.
186 Dietz Bldg. WASHINGTON, D. C.

GOES LIKE SIXTY
SELLS LIKE SIXTY
SELLS FOR SIXTY
$60
GILSON
GASOLENE
ENGINE
For Pumping, Cream Separators, Churns, Wash Machines, etc. FREE TRIAL
Ask for catalog—all sizes
GILSON MFG. CO. Park St. Port Washington, Wis.

A Clean Engine Room



In many engine rooms oil is not only wasted, but it is allowed to saturate the floor and accumulate under and around the engine foundation. This wasteful and unsightly condition can be avoided by catching the drippings and filtering them through a BURT "UNIT" OIL FILTER, thus saving many dollars in oil and avoiding the danger and dirt otherwise entailed.

Our new 80-page catalog describes and illustrates our various Filters, Ventilators and Exhaust Heads. You should have a copy.

The Burt Manufacturing Co.
204 Main St., Akron, O., U. S. A.

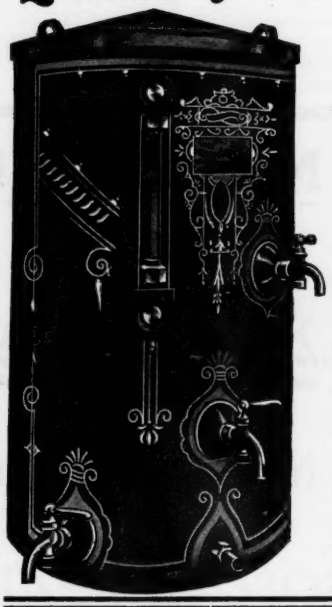
Great Capacity

NOTICE—Sliding Sleeve damper can be furnished with metal top if desired. (Patented).

Extraordinary ventilating power and capacity; most thorough, workmanlike construction from the best materials; patent sliding sleeve damper, storm and dust proof, open or shut; easily set and stays where you want it; furnished with glass top if you desire, making a practical skylight from which light cannot be shut out. Send for special circulars.

The Burt Manufacturing Co.
204 Main St., Akron, O., U. S. A.

Quantity and Cost



The cost per gallon of oil and the quantity purchased constitute but one factor in the cost of lubrication. PERFECT lubrication reduces friction and saves power, and that means economy of coal.

You can have this perfect lubrication through a Cross Oil Filter. It makes possible the use of the best grades of oil at a lower cost than the poor oil costs you now. Try one 30 days free.

The Burt Manufacturing Co.
204 Main St., Akron, O., U. S. A.
Also supplied by Engine Builders, Dealers and Power Contractors. Agencies in nearly all the principal cities of the world.

Hundreds of Users

We could give you the names of hundreds of plant owners—big and little—who use the Burt Exhaust Head, and who wouldn't have any other since they have learned of its merits.

You might be interested in knowing the opinion of some of these firms. If so, write and ask for the list.

The Burt Exhaust Head is fully guaranteed and sold on 30 days trial.

The Burt Manufacturing Co.
204 Main St., Akron, O., U. S. A.
Also supplied by Engine Builders, Dealers and Power Contractors. Agencies in nearly all the principal cities of the world.

W. A. Ruggles, 54 High Street, Boston, is New England agent for National Feed Water Heaters, White Star Filters and Oiling Systems, Gould Feed Water Regulators, Baum Separators and other power plant specialties, with all of which he is doing well. Mr. Ruggles is highly esteemed and very popular.

The Cline Feed Water Heater Co., Fulton Building, Pittsburg, Pa., issue a circular describing the Everlasting Feed Water Heater, which will doubtless interest engineers who are contemplating the purchase of a new heater. The special feature of the Everlasting heater is the ease with which it can be cleaned. The tubes being straight, may be cleaned in the same manner as boiler flues, by simply removing the brass plugs at end of tube, thereby keeping the heater always in a condition of highest efficiency.

It's not long since page 72 was the last page of THE PRACTICAL ENGINEER. Indeed it's as follows: 1-7 inch to The Cummer-Diggins

Any reader of THE PRACTICAL ENGINEER contemplating the purchase of a new engine, either steam or gas, will do well to consult the very excellent catalogue of the Buckeye Engine Company, of Salem, Ohio. When asking for this catalogue state whether you are interested most in their steam or their gas engines.

M. T. Davidson Company, 154 Nassau Street, New York, have just issued a splendid new catalogue devoted to pumps and pumping engines which should be in the hands of every power-plant man. It contains 96 pages, 6x9 inches, is richly illustrated and full of data and information that is indispensable to those in charge of, or who are contemplating the installation of, pumping machinery. A copy of this excellent catalogue will be mailed to any reader of THE PRACTICAL ENGINEER.

The Ashton Valve Company, 271 Franklin Street, Boston, Mass., has issued a fine new calendar for 1908, copies of which may be had for 10 cents each.

Judging from that picture of Uncle Sam in the advertisement of the Wm. B. Pierce Company, on page 64, one would not think he had any fear of general business conditions.

Wilkinson Automatic Stokers have come into such general use that most engineers are entirely familiar with their many advantages over hand-firing. To those who are not, the picture on the front cover of this issue is an apt illustration. The difference between the work of the man who is shoveling coal into the furnace and the other man, who is attending the stokers, is not exaggerated. These are days for automatic machinery; the stoker is winning over old methods just as automatic machinery has won in every other field and as it always will, for men are learning that the hard, slavish labor in front of a boiler furnace is neither human nor economical.

The "Rapid" Turbine Tube Cleaner is illustrated in a catalogue issued by the Thos. Andrews Mfg. Company, Rockaway, N. J. Some of the advantages claimed for this cleaner are that the cutter-arms are forced out firmly against the scale but that they cannot extend beyond the inside diameter of the tube; also, that it has no balls or cones to break or keep in repair. The catalogues describes the cutter in detail; it also shows the "Rapid" Hose Coupling, for use in connection with the cleaner, which can be made to fit the variations in sizes of hose.

The Ohio Blower Company, Cleveland, Ohio, report recent sales of the "Swartwout" Helico-Centrifugal Cast Iron Exhaust Head as follows: Two each to Missouri Pacific Railroad Company, and Mississippi Cotton Oil Co., Natchez, Miss.; 1-5 inch to Municipal Light Plant, Hamilton, Ohio; 1-10 inch to Narragansett Brewing Co., Providence, R. I.; 1-16 inch to Alliance Gas & Blower Co.; 1-6 inch to Garfield Worsted Mills, Passaic, N. J.; 1-10 inch to Union Typewriter Co., Bridgeport, Conn.; 1-16 inch to Wheeling Traction Co., Wheeling, W. Va.; 1 to Waterbury Castings Co., Waterbury, Conn.

"A Brief About Hot Water," is the title of a folder being distributed by the Harrison Safety Boiler Works, No. 3144 N. Seventeenth Street, Philadelphia. The reading matter relates particularly to the uses of hot water in textile establishments, pointing out that water for dye tubs, washing and scouring, boiler feeding, etc., can be heated more economically by means of exhaust steam than with live steam or by direct application of fire.

The Western Packing & Supply Company, 253 La Salle Street, Chicago, want to send a sample of Casco Bar-Metallic Packing and a copy of their new 1908 Catalogue to all engineers writing them for same. "Casco" is an all-metallic rod packing, put up in small bars or segments, for convenient application. It is said to be particularly efficient for the packing of Corliss valve stems or other rotary work where old-style packings prove unsatisfactory.

One of the most popular specialties now in the steam field is the Reflex Water Gauge. This gauge is different from the ordinary variety, in that the water in the tube shows black, thus always presenting a distinct and unmistakable water-line which can be seen ever in dark corners where the water-line in other gauges is difficult to see. A catalogue describing the Reflex Gauge and a number of other interesting steam specialties is issued by the manufacturers, Jerguson Mfg. Company, 223 Columbus Avenue, Boston, Mass.

MARCO JUPITER expansion packing has become famous for its great strength and durability. This packing is made of layers of heavy duck, cut bias, and laid edgewise to the rod, which is said to contribute to its durability. The layers of duck are held together by high-grade rubber frictioned through the fibres and the whole is backed by an expansion cushion of thick rubber reinforced by heavy duck, thus giving perfect expansion during the life of the packing. The Marco Catalogue shows this packing in detail and also other packings and mechanical rubber goods. A copy of the Marco Catalogue can be had by writing the Cleveland Rubber Works, 74 Lisbon Street, Cleveland, Ohio.

When thinking about injectors, ejectors, boiler checks, check valves, etc., write to Rue Mfg. Company, 228 Cherry Street, Philadelphia, for catalogue.

The Kelley Mechanical Draft System is said to be meeting with popular favor among engineers. It is especially useful where the natural draft is insufficient or where an increase of power is desirable. It can be automatically controlled to accelerate the draft when the pressure drops and to reduce draft as the pressure rises to the desired point. A circular describing its operation may be had from Chas. T. Luce Company, 160 Congress Street, Boston, Mass.

Fill out the coupon in the advertisement of F. S. Walton Company, on another page of this issue and mail it as per directions, and they will send you a can of OxoilOx free. With this dressing it is claimed that more power can be gotten out of a slack belt than with a tight belt where OxoilOx is not used. It is also recommended as an infallable preventative for cracking and all deterioration of leather belting, prolonging the life, increasing the efficiency and pulling power of new belts and putting back much of the original life and flexibility into old belts. Fill out the coupon if you want a sample can free.

The Kutztown Foundry & Machine Company, Kutztown, Pa., have issued a very handsome calendar for 1908.

NEW POWER PLANTS AND IMPROVEMENTS

The Smith & Dove Mfg. Company, of Andover, Mass., will build a new power-plant in the spring.

The citizens of Farmland, Ind., are considering the question of installing a municipal electric light plant.

Extensive improvements and additions will shortly be made to the Brockville, Ont., municipal light and power plant. C. W. Wilkinson is manager.

Now Ready!

Our New Line
OF
25c. BOOKS
FOR ENGINEERS
Nearly 60 Titles

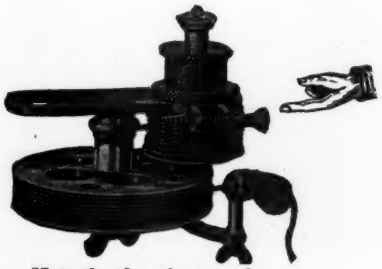
Send at once for full descriptive Circulars
FREE

Spon & Chamberlain
Publishers of Technical Books
123 P. E. Liberty St.,
NEW YORK

The Robertson-Thompson Indicator

Victor Reducing Wheel

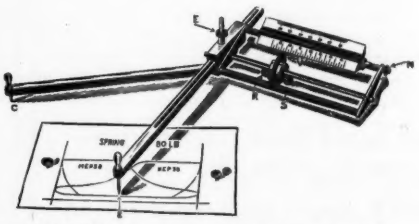
Willis Planimeter



Note the thumb screw for changing tension of card spring

The Finest Instruments Made

No engineer can be really progressive until he owns an indicator outfit and knows how to use it.



Gives M. E. P. without computation

Easy Terms and Prices Make Easy Buying

JAS. L. ROBERTSON & SONS, Inc.

INCORPORATED

40 WARREN STREET, NEW YORK

It is proposed to erect a new municipal electric light plant in Hot Springs, Ark., at a cost of about $30,000. G. M. French is engineer.

The Bristol Gas and Electric Company, of Bristol, Va., will expend about $100,000 for improvements in the near future. S. M. Vance is superintendent.

The City Council of Easton, Md., is considering propositions for granting a franchise for a light, heat and power plant. Martin M. Higgins is mayor.

The Blackhawk Light, Heat & Power Company, of Vincennes, Ind., has filed articles of incorporation in Illinois and will locate their plant at Marshall, Ill.

A large power-house will be erected for the Becker-Brainerd Milling Company, at Hyde Park, Boston, Mass. Work will be begun early in the spring.

The Green River Electric Light & Power Company, Green River, Wyo., is contemplating duplicating the present equipment of its plant. George H. Maxam is manager.

The Tucannon Power Company, of Pomeroy, Wash., is installing a steam plant to be used as an auxiliary to its water-power plant. W. W. Richards is manager.

The citizens of Walker, Minn., are contemplating duplicating the present equipment of the municipal electric light plant. John E. Gray is chief engineer and electrician.

The Sheffield Brick and Tile Company, of Sheffield, Ia., is contemplating installing an electric light plant for its own use and also to furnish electricity for lighting the city.

W. S. Ingram, owner and manager of the Terra Alta Electric Light Plant, is installing a new power-plant at Terra Alta, W. Va. Bids for a switchboard and a closed-feed water-heater will be received.

Plans are being prepared for the new power-house which will be erected by the Continental Realty Company, Milkaukee, Wis. The cost of the plant is estimated at $50,000. Kirchoff & Rose are the architects.

The Stanberry Electric Light and Power Company, Stanberry, Mo., is contemplating increasing the equipment of its plant and will install two boilers, an engine and a dynamo. J. R. Creighton is manager.

The large dam of the Bar Harbor and Union River Power Company, at Ellsworth, Me., is practically completed and it is expected that the new power-house will be in readiness for operation early in February.

The Trustees of the Consumptives' Hospital, of Boston, Mass., will build a new power-house on the hospital grounds, River Street, Mattapan, Boston. Edw. F. McSweeney, Chairman, Board of Trustees.

Plans for a new power-house for the Bigelow Carpet Company, Clinton, Mass., are being prepared by Main & Simpson, architects, Boston. The new power-house will furnish the company's mills with heat and light.

The City Council of Freemont, Neb., has adopted the revised plans of C. A. Chapman, of Chicago, Ill., for a power-house for the water and light plant, to cost about $23,045. Frank Hammond is secretary of Board of Public Works.

Cyrus Bousman, of Saratoga, Ind., will receive bids for the installation of an electric light plant in connection with his hotel. Mr. Bousman also proposes to furnish electricity to light the town, including business houses and dwellings.

The Board of Public Works of Milwaukee, Wis., will build a new gas producer plant as an addition to the municipal electric light plant, Walker and Davidson Streets. Bids will be received until February 13th, for furnishing and erecting, ready for use, all machinery and appurtenances to install a complete gas-producer plant. Plans and specifications can be secured on a deposit of $25. Chas. J. Poetsch is chairman.

SOCIETY NEWS

Mayor Edgerton, of Rochester, N. Y., has reappointed the members of the Examining Board of Stationary Engineers as follows: Henry J. Dengler, Willard Bond and Chas. J Dowger.

The members of No. 2, N. A. S. E., of Pawtucket, R I., are again agitating for a license law for the State of Rhode Island.

Mr. Wm. Holmes delivered an interesting lecture on "Boiler Combustion and Air Supply," at the Modern Science Club, Brooklyn, on January 14th. Mr. A. Wohlgemuth lectured at the same club on the evening of January 7th, his subject being "The Practical Operation of Storage Batteries."

Two new Examiners of Engineers have been appointed to the Boiler Inspection Department of the Massachusetts District Police. The new appointees are Edward Moran, engineer at the Riverside Boiler Works, in Cambridge, and Arthur F. Lovering, Framingham, Mass., chief engineer of the power-plant of the Boston & Worcester Street Railway Company, at South Framingham.

Lehigh Council, No. 15, A. O. S. E., of Allentown, Pa., has elected the following new officers to serve for the ensuing term: Chief Engineer, Lloyd Schaffer; First Assistant, C. O. M. Bear; Recording Engineer, C. A. Dreisbach; Financial Engineer, A. J. Strauss; Corresponding Engineer, Sol. Fehnel, 445 Tilghman Street; Chaplain, Henry Snyder; Senior, M. M., Chas. Silfies; Junior M. M., Edwin Miller; Inside Sentinel, Geo. Graber; Outside Sentinel, Edmund Brader; Treasurer, John Burley; Trustees, A. P. Dreisbach, Edmund Brader and Wm. Stahler; Delegates, Solomon Fehnel and Hiram Roth. Lehigh Council meets every Thursday evening at 639 Hamilton Street, Allentown. The Council has recently lost an old and valued member—Brother Chas. W. Wienard, who died on December 14th. At the regular meeting of the Council on December 19th, resolutions were adopted expressing regrets and sympathy with the bereaved family.

The Engineers' Club of Philadelphia held their first meeting in their new club house, at 1317 Spruce Street, on January 4th. On January 11th, an informal housewarming was held, to which many men prominent in engineering and political circles were invited. A fine collation was served and the members and invited guests had ample opportunity to make new acquaintances and renew old friendships. On January 18th, the annual election of the club was held, which resulted as follows:

President, H. W. Spangler; Vice-Presidents, Washington Devereux, Wm. Easby, Jr.; Secretary, Francis Head; Treasurer, George T. Gwilliam; Directors, F. E. Dodge, J. O. Clarke, H. G. Perring, Henry H. Quimby, Wm. S. Twining, James Christie, H. P. Cochrane, Richard G. Develin, Henry Hess.

The retiring President, Henry H. Quimby, delivered the annual address at this meeting. He reviewed the history of the club and gave some very instructive advice as to the relationship of the engineer to his profession.

The club membership now numbers over 600 and it is expected that with the new facilities afforded by its palatial new club home, large accessions to its membership will be made.

OBITUARY

Theodore L. Webster, Secretary of the Warren Webster Company, of Camden, N. J., met a sudden and untimely death in a crash of railroad trains in Camden, on December 27th. Theodore Webster was well known in local engineering circles, and was deservedly popular. Though but 38 years of age he had been connected with The Warren Webster Company since its establishment, twenty years ago, during which time he had endeared himself to all his associates and employes.

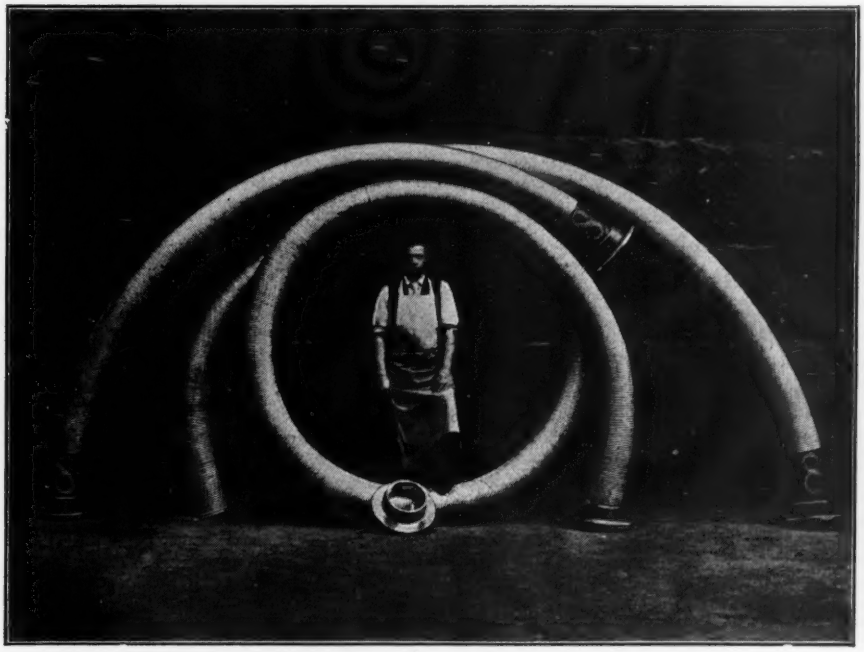
Charles W. Martin, Jr., one of the best known and most popular supply men in the United States, died on December 31st, of pneumonia, at the age of thirty-seven years. At the time of his death he was assistant general manager of Jenkins Bros., the well-known firm of steam valve manufacturers, and during the twenty years that he was employed by that firm he made his personality felt throughout the length and breadth of this country. His jovial disposition and charming manners made him an ever-sought-for companion by its fellow-employes and friends, and the many societies to which he belonged have lost a member whose worth can scarcely be replaced. He was an honorary member of Nos. 7 and 8 of the National Association of Steam Engineers, an honorary member of the Marine Engineers' Beneficial Association of New York; a charter member of the Modern Science Club of Brooklyn, and Steam Engineers' Club of New York. He organized the Supplymen's Associations of the N. A. S. E., the I. U. S. E. and the M. E. B. A., and he was connected with the Supplymen's Association of the Master Mechanics and Master Car Builders' Association.

He is survived by a widow and two little children, a daughter of five years and a son of two years.

As a token of their love and respect for their fellow member, the combined associations of the N. A. S. E. of Manhattan and the Bronx, New York City, met on January 6th, and unanimously adopted a set of resolutions expressing their great sorrow and extending their sympathy and heartfelt regrets to his bereaved family.

METAL HOSE

For all work where high pressure, rough service and durability are required



SOME LENGTHS OF 8-INCH FLEXIBLE METALLIC TUBING.

For STEAM, OIL, AIR, WATER, GAS, Etc.

Made in all Sizes from 1-8 to 12 Inches

Flexible Metal Hose has been put to the test and has proven its superiority over rubber hose. It is being used by advanced engineers for high pressure steam and suction work. Metel hose made with INTERLOCKING JOINT is absolutely safe, and is always steam tight. Ask for "Interlocking Joint." Prices and description shown in our new booklet.

Pennsylvania Flexible Metallic Tubing Company

1305 Arch Street, - - - PHILADELPHIA, PENNA.

NEW YORK—86 WARREN ST. CHICAGO 255 La SALLE STREET BOSTON—71 HIGH ST.

RECENT BOILER EXPLOSIONS AND POWER PLANT ACCIDENTS

The Municipal Electric Light Plant, at Elma, Ia., was completely destroyed by fire December 29th, causing a loss of about $6,000.

The breaking of a heavy driving-belt from the flywheel of an engine in an oil mill at Hollandale, Miss., December 30th, wrecked the building and caused damages to the extent of $5,000.

The flywheel of an engine in the R. W. Pridham Paper Box Works burst December 31st, cutting through a wall and injuring an employe.

On December 31st a large boiler in the plant of the Mannequa Cooperage Company, Little Rock, Ark., exploded, doing considerable damage. No one was injured.

On January 2nd the power-house and carbarns of the Butte Street Railway Company, Butte, Mont., were destroyed by fire.

On January 3d a boiler in the sawmill of J. C. Gilham, Elsy, Mo., exploded, wrecking the mill and injuring six.

As a result of the bursting of a boiler-tube on January 3d in the power station of the P. M. & I. Co., Marietta, Ohio, one man was killed and another seriously burned.

The bursting of a 20-in steam pipe at the Birmingham Railway Light and Power Company's plant, Birmingham, Ala., on January 3d, seriously burned one man and injured another.

A boiler in the sawmill of R. Walters, near Bath., Ky., exploded January 5th, killing J. Justice, the engineer, and badly injuring Walters.

Two men were instantly killed and several others injured by the explosion of a boiler in a sawmill at Sedan, Ohio, on January 7th.

A fourteen-foot flywheel in the plant of the National Rolling Mill Company, Vincennes, Ind., flew to pieces January 8th, causing a loss of $2,500.

A boiler in the plant of F. G. Tigglebeck & Co., Wheeling, W. Va., exploded on January 9th, causing damages to the extent of $800.

NEW BOOKS

Hendrick's Commercial Register of the United States for Buyers and Sellers. By S. E. Hendricks Company, New York City. Sixteenth edition. 1300 pages. Price, $10.

This directory, which is now in its sixteenth year of existence, is one of the most complete of its kind published. It contains over 350,000 names and addresses with 31,212 trade headings.

"Water Supply," by Frederick E. Turneaure. Size, 6½ x 9½. 150 pages and 40 illustrations. Published by the American School of Correspondence, Chicago, Ill. Price, $1.00.

This book, which is written for the benefit of those interested in sanitary and waterworks engineering, covers the field of water supply, its distribution and purification, the construction of wells, reservoirs, pipe lines, drainage systems, etc. These subejcts are all treated from the practical standpoint and the book is particularly free from long hydraulic formulæ which is so common in books of this kind. A number of full page half-tones are shown illustrating the magnitude of various hydraulic undertakings. This book should prove useful to hydraulic engineers and others who have anything to do with water supply and its utilization.

"The Gas Engine in Principle and Practice," by A. H. Goldingham. Size, 6 x 9. 195 pages and 107 illustrations. Published by Gas Power Publishing Company, St. Joseph, Mich. Price, $1.50.

This book is one of the few that has been published on the gas engine which describes in clear language, without the use of thermodynamic formulæ the principles of the gas engine and its operation. Starting in with a description of the various types of gas engines, it describes the various types of valves and valve motions, governors and igniters. The indicator and brake methods of testing the engine are described and the different types of fuels, as well as gas producers, are explained.

While there is nothing particularly new in the book, the different subjects are treated in a simple and non-mathematical way, so that it should be of particular value to the practical man who is interested in gas engines.

"How To Use Water Power," by Herbert Chatley. Size, 5 x 7½. 90 pages and 23 illustrations. Published by D. Van Nostrand Company, New York City. Price, $1.00.

The utilization of water-power in connection with the generation and transmission of electric power, has made the subject of hydraulics an important branch of modern engineering. Not only must the engineer understand the proper method of using the water power at his command but he should know how to extract the greatest amount of energy from a given quantity of water. With the object of explaining the methods and principles of hydraulic engineering as at present practiced, this book has been written. It takes up the sources and transmission of power, the hydraulic press, water wheels, turbines, pumps, hydraulic engines, tidal power, water supply and sewage disposal.

While naturally each of these subjects is treated briefly, it gives a general survey of the hydraulic branch of engineering to those who have a limited knowledge of mechanics and mathematics.

"Engine Room Chemistry," by Augustus H. Gill. Size, 4½ x 7. 197 pages, 47 illustrations and 12 tables. Published by the Hill Publishing Company, New York City. Price, $1.00.

The subjects in this book, which relate to fuel, water and lubricants, are treated clearly and admirably, and are the results of Professor Gill's experience, which he has had at the Massachusetts Institute of Technology.

As a treatise on the analysis of fuels, the regulation of combustion, the pitting and corrosion in a boiler, the formation of boiler scale, and the discussion of mineral, vegetable and animal oils, this book may be said to be a valuable addition to any scientific library. As a book, however, which is to be used in the engine room by an operating engineer, it cannot be recommended, as it involves a thorough knowledge of chemistry and physics, which subjects are taught principally in high schools and colleges, and the experiments described require apparatus which will only be found in a well-equipped laboratory. The chapter on gas analysis, which is the best in the book, is a repetition of what has appeared in another book on the same subject written by the same author.

"Making and Reading Drawings," by A. Edward Rhodes. Size, 6 x 9½. 64 pages, 67 illustrations and 25 full page plates. Published by A. Edward Rhodes, Wilmington, Del. Price, 75 cents.

This book is written especially for home study and its particular object is to enable the student to make and read drawings. It takes up the subjects of care and use of instruments, orthographic projections, isometric and perspective drawings, geometrical problems, intersections, elementary machine design and architectural drawing.

While it has always been a matter of doubt as to whether a student can learn the subject of mechanical drawing from a book, yet at the same time there is no doubt but that the proper use of a book will help him in the better understanding of many of the problems encountered on the drawing board. Mr. Rhodes has had considerable experience as a teacher, draftsman and writer, and his book explains what he thinks the average student of mechanical drawing needs.

The book, however, is so poorly printed that much of its value is lost by the effect poor printing has on the reader. If more time were spent on this important part of the book, its contents would possess considerably more merit.

A Treatise on Hydraulics, by William C. Unwin. Size 5½x8½. 327 pages, 148 illustrations and 8 tables. Published by Adam & Charles Black, London, England, and Macmillan Co., New York, Price, $3.25.

The writings of Professor Unwin are so well known to the technical student that anything but favorable comment on this latest book would seem presumptious. To the engineering student, who must of necessity understand the application of the various imperfect theories and empirical formula, the book should be a decided help; but to the practical man who is looking for results from any piece of machinery or hydraulic condition, it is doubtful whether it would aid him any more than one of the many handbooks in which the usual hydraulic formula and their constants occur.

The book takes up in detail the properties of fluids, principles of hydraulics, discharge from orifices, notches and weirs, flow of water in pipes, distribution of water by pipes, uniform flow of water in canals and conduits, and impact and reaction of fluids.

Of necessity, higher mathematics, including algebra, is used to explain the various subjects, but this adds confidence to the different explanations, and shows better than any method, the limitations of the usual hydraulic formula.